Tables

Figures

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Appendix D1. Wetland Reconnaissance Memo

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Wetland Reconnaissance Memo

To:	Project File
From:	Jon Schick, CEP, HDR Environmental Scientist Mark Traxler, HDR Senior Environmental Scientist
Project:	Milk River and St. Mary River Watersheds Plan-EIS
Date:	Friday, January 05, 2024

D1.1 Wetland Reconnaissance

This memorandum documents the methodology used and the results of a wetland reconnaissance survey for the Milk River and St. Mary River Watersheds Plan-Environmental Impact Statement (Plan-EIS). The purpose of the field reconnaissance was to identify aquatic resources adjacent to the St. Mary Canal within the defined survey area. In addition, this memorandum will support Chapter 3, Affected Environment, and will ultimately be used to assist in reviewing potential effects to aquatic resources that may result from each alternative.

D1.1.1 Methodology

On September 26-27, 2023, the survey area was visited by HDR environmental scientists, Mark Traxler and Jon Schick, to review general site conditions and visually document aquatic resources along the St. Mary Canal (Canal). The survey area is entirely located on the Blackfeet Indian Reservation. The project team coordinated with the Tribe and the Blackfeet Wetland Manager, Emerald Grant III, who accompanied HDR on the field investigation on September 26, 2023.

The Canal access road was driven, and representative areas of wetland and upland habitat were documented based on visual observation of vegetation and hydrology. An EOS Arrow 100 Submeter GNSS/GPS Receiver was used to log points and collect georeferenced site photos. Points for representative wetland areas and photo points were recorded with the internal GPS of an iPad Pro tablet. It was determined that the internal GPS accuracy of the iPad was sufficient for the purpose of the reconnaissance. Horizontal accuracy averaged approximately 10 feet. Points and photographs were recorded on the iPad using ESRI Field Maps. The data was synced to ArcGIS Online and downloaded to ArcGIS Pro for desktop analysis. Georeferenced photos were taken at most wetlands and at regular intervals along the entire length of the Canal. All photos taken during the field visit are available for viewing in the ArcGIS online project folder.

Aerial imagery base maps within ArcGIS Pro were used in conjunction with the field observation points to identify and digitize probable wetland areas. The aerial imagery used is the standard world imagery service available from ESRI; the aerial photo source is Maxar and collection dates were from 2019 and 2022. Field observation data points and visual interpretation of aerial imagery photo signatures, probable wetland areas were digitized and coded according to wetland classification. The predominant wetland types in the area are either palustrine emergent wetlands (PEM), palustrine scrub-shrub (PSS), or palustrine aquatic bed (PAB). The extent of the Canal was digitized using engineering survey CAD data to identify the typical high-water mark within the Canal during the irrigation season. Portions of the survey area representing riverine habitat (i.e., St. Mary River and North Fork Milk River) were digitized by visually interpreting aerial imagery. At the time of the field investigations, the St. Mary Diversion Dam was closed, and the Canal shut down for the season. Shallow, residual water was encountered within much of the Canal during the field investigation.

The goal of the field reconnaissance was to document probable wetland areas to allow for a desktop analysis and quantification of project area aquatic resources to inform future impact analyses during the environmental review process. The field investigation did not include a formal delineation of wetlands. A formal wetland delineation will be conducted during final design and permitting process.

D1.1.2 Survey Area

The survey area encompasses a 300-foot-wide buffer centered on the Canal (150-feet on either side of the Canal centerline) as well as a 100-foot-wide buffer centered on the Canal access roads (50-feet on either side of the roads). The survey area includes areas where potential direct effects from the proposed Canal modernization project are likely to occur. The survey area totals 1,095 acres.

D1.1.3 Disclaimer

It is important to point out that the desktop evaluation likely under reports the actual area of wetlands within the survey area. This is due to several factors: (1) the general limitations of the desktop analysis and limited field observations; (2) the field investigations occurred in late fall when hydrological indicators are less evident; and (3) observations were limited to areas accessible via access road.

D1.2 Results

The following section summarizes the results of the wetland field reconnaissance and associated desktop evaluation.

D1.2.1 Summary of Aquatic Resources

The areas of aquatic features were calculated and are reported in Table D1-1. The results from the desktop evaluation are shown in the Preliminary Identification of Aquatic Resources Map Set included as Appendix D1.3.

Table D1-1. Summary of Aquatic Resources in Survey Area

Aquatic Feature	Area Sum (acres)
Wetland, Emergent (PEM)	44.7
Wetland, Scrub-Shrub (PSS)	1.0
Wetland, Aquatic Bed (PAB)	0.3
Total Area of Wetlands	**46.0**
Irrigation Canal, open water	254.3
River, Waters of the U.S. (i.e., St. Mary, Kennedy Creek, North Fork Milk River)	4.0
Total Area of Aquatic Resources	**304.3**

Source: HDR 2023
Notes: Wetland areas are preliminary and based on desktop analysis.

As shown in Table D1-1, the survey area includes approximately 46.0 acres of wetland habitat and approximately 258.8 acres of surface waters. The Canal encompasses 254.3 acres of surface area (approximately 23 percent of the total project area). The total area of aquatic resources within the survey area is approximately 304.3 acres.

The wetland boundaries digitized in the desktop evaluation are preliminary and do not represent formally delineated wetlands. The preliminary wetland boundaries are for planning purposes only and are not intended for permitting. No evaluation has been made relative to the jurisdiction of the aquatic resources identified under Section 404 of the Clean Water Act.

D1.2.2 Description of Wetlands

General descriptions of wetlands are provided in the following sections. Canal mileposts (MP) are referenced, which run from the diversion dam (MP 0) to the end of the Canal at the Drop 5 structure (MP 28.1) where the Canal discharges to the North Fork Milk River. For consistency, wetland descriptions along the Canal include a left/right direction assuming a centered location on the Canal facing downstream (towards MP 28.1).

Wetland hydrology throughout the length of the survey area is convoluted and difficult to ascertain in some cases. Many of the identified wetlands are directly tied to water flowing in the Canal. Additionally, several headgates are located along the Canal where water is released at seasons end to drain the Canal. Many of the receiving drainages appeared to contain wetlands. Other sources of hydrology include bisected named and unnamed channels, and shallow groundwater resulting in naturally occurring prairie pothole features. It is unclear from this brief reconnaissance survey the extent that seepage from the Canal plays into the hydrology of adjacent wetlands, however; it is likely some seepage contributes to the presence of adjacent wetland habitat. Additional hydrologic discussion is provided in the subsections to follow.

MP 0 – 4.75 (Kennedy Creek)

Wetlands along this stretch of the Canal are frequently established on the left side of the Canal along the fringes of the numerous small open water bays and ponds that exist due to an unconfined channel on the left side. Wetlands observed were consistently sedge-dominated (*Carex spp.*) PEM wetlands that either fringe the Canal or where larger emergent wetlands have formed (see Photo D1-1).

At MP 2 there is a large wetland complex east of the Canal and outside of the survey area where areas of open water and PSS wetland encroach on the project area boundary. Visibility and access to the east side of the access road was limited and more detailed investigations along the embankment and toe of slope would be necessary if project impacts are anticipated at this location.

The USGS National Hydrography Dataset (NHD) shows seven streams that flow steeply from the west before directly intersecting with and terminating at the Canal. Some of these stream channels were visible from the access road on the opposite side of the Canal while many others were not. Minimal areas of fringe PEM wetland were observed, primarily due to the steeper and unsuitable topography. Further investigation of these locations is recommended to identify the presence/absence of streams and delineate bed and bank features if present. A summary of aquatic resources within this project segment is provided in Table D1-2.

Photo D1-1. Representative sedge-dominated wetland at approximately MP 0.9, looking southeast.

Table D1-2. Summary of Aquatic Resources within the MP 0 – 4.75 Segment

Aquatic Feature	Area Sum (acres)
Wetland, Emergent (PEM)	2.74
Wetland, Scrub-Shrub (PSS)	-
Wetland, Aquatic Bed (PAB)	-
Irrigation Canal, open water	43.64
River, Waters of the U.S.	0.86
Total Area of Aquatic Resources	**47.2**

MP 4.75 (Kennedy Creek) to MP 9 (St. Mary Siphon)

Due to private property and access restrictions, the segment of Canal from approximately MP 4.75 to MP 7 was not investigated and therefore information is limited. From approximately MP 4.75 to 6, conditions resemble the previous section of Canal—small emergent wetlands fringe open water areas on the left side of the Canal. The Canal moves eastward away from the foothills and crosses the historic floodplain of Kennedy Creek. At approximately MP 6, Powell Creek crosses underneath the Canal through a culvert with wetlands on the left side and potentially on the right side as well. At approximately MP 7, an unnamed stream intersects the Canal from the north to form a wide, open water area (see Photo D1-2). There are several natural pothole type wetlands in this vicinity. At this location, on the left side of the Canal but outside the survey area, an approximately 8-acre pond is hydraulically connected to the Canal presumably by a culvert underneath the access road. This area is located on private property and was not accessible during the field reconnaissance. Adjacent to where the Canal runs parallel to Camp Nine Road, the Canal widens in a few locations to form PEM/PSS wetlands. Notably, the U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI) data shows extensive wetlands along this section, primarily on the right side of the Canal. Further investigation of this area is warranted if impacts from the project are anticipated.

From approximately MP 7 to MP 9, access was available via the access road on the left side of the Canal, whereas areas on the right side of the Canal were not accessible. This segment contains minimal areas of emergent wetlands on the left side of the Canal (see Photo D1-3). In addition to sedge, areas of reed canarygrass (*Phalaris arundinacea*) were observed. Since the right side of the Canal was not accessible, further investigation would be needed to identify the presence/absence of wetlands if impacts are anticipated. A summary of aquatic resources within this project segment is provided in Table D1-3.

Photo D1-2. Open water area at MP 7, looking southwest.

Photo D1-3. Representative emergent wetland adjacent to the Canal at approximately MP 7.5.

Table D1-3. Summary of Aquatic Resources within the MP 4.75 – MP 9 Segment

Aquatic Feature	Area Sum (acres)
Wetland, Emergent (PEM)	1.27
Wetland, Scrub-Shrub (PSS)	0.21
Wetland, Aquatic Bed (PAB)	0.27
Irrigation Canal, open water	43.08
River, Waters of the U.S.	1.27
Total Area of Aquatic Resources	**46.1**

MP 9 to MP 9.5 (Saint Mary Siphon)

At approximately MP 9 the St. Mary Siphon begins and traverses the river drainage and crosses the St. Mary River on a steel truss bridge. No wetlands were observed along the siphon (see Photo D1-4). Similarly, the banks of the St. Mary River at the siphon crossing are relatively steep and no wetlands were observed along the river. A summary of aquatic resources within this survey area segment is provided in Table D1-4.

Photo D1-4. St. Mary Siphon, view from near the river looking northwest (upstream).

Photo D1-5. St. Mary River Siphon crossing, looking northeast.

Table D1-4. Summary of Aquatic Resources within the MP 9 – MP 9.5 Segment

Aquatic Feature	Area Sum (acres)
Wetland, Emergent (PEM)	-
Wetland, Scrub-Shrub (PSS)	-
Wetland, Aquatic Bed (PAB)	-
Irrigation Canal, open water	-
River, Waters of the U.S.	0.97
Total Area of Aquatic Resources	**0.97**

MP 9.5 to MP 14

At approximately MP 9.5 the Canal exits the St. Mary Siphon. At MP 9.6 a wetland with a PSS component was observed at the downhill toe of the access road embankment. Minimal wetlands were observed between MP 9.6 and MP 10.5. At approximately MP 10.5 the Canal widens and forms Spider Lake, and narrow PEM wetlands exist where ponded water forms a backwater channel on the right side of the Canal at the inlet.

At approximately MP 11.4, a PEM wetland exists on the left side of the Canal in an area that appears to be the headwaters/source of Willow Creek, which flows parallel to the Canal for over two miles. No wetland areas were identified between MP 11.8 and MP 13.9. A summary of aquatic resources within this survey area segment is provided in Table D1-5.

Photo D1-6. Emergent wetland at approximately MP 11.4 at source of Willow Creek, looking north.

Table D1-5. Summary of Aquatic Resources within the MP 9.5 – MP 14 Segment

Aquatic Feature	Area Sum (acres)
Wetland, Emergent (PEM)	2.31
Wetland, Scrub-Shrub (PSS)	0.19
Wetland, Aquatic Bed (PAB)	-
Irrigation Canal, open water	38.63
River, Waters of the U.S.	-
Total Area of Aquatic Resources	**41.12**

MP 14 to MP 25.9 (Drop 1)

Water flows from west to east over this section of the Canal and the topography generally slopes to the north. The Canal intersects numerous streams and intermittent drainages that flow to the north, as well as intersecting many wetland areas. This 12-mile section of Canal has a high concentration of wetlands many of which are established at the toe of the access road embankment on the north side of the Canal. The hydrologic connections between the Canal and adjacent wetlands are varied throughout this segment: some wetlands exist where drains or wasteways provide hydrology to down-gradient areas, while other wetlands appear to receive hydrology from the Canal through groundwater connection/seepage. It is likely that the Canal supports wetlands on the north side of the Canal to some extent through groundwater discharge or seepage. Cow Creek is intersected by the Canal at approximately MP 14.8 (see Photo D1-7). The Halls Coulee Siphon is located at approximately MP 16.8 (see Photo D1-8) where small areas of wetland exist along the drainage. Wetlands observed throughout this section of the Canal are predominantly PEM and vegetation types include sedge, foxtail (*Alopecurus spp.*), among other grasses and forbs. Willow (Salix spp.) were observed intermittently through this section of the survey area, although at densities too low to be considered PSS wetlands (see

Photo D1-9 for representative wetland). A summary of aquatic resources within this survey area segment is provided in Table D1-6.

Photo D1-7. Cow Creek at MP 14.8 and adjacent wetland habitat, looking northeast.

Photo D1-8. Halls Coulee Siphon, intermittent drainage, and narrow emergent wetland, looking south.

Photo D1-9. Representative wetland at MP 23.7, looking north.

Table D1-6. Summary of Aquatic Resources within the MP 14 – MP 25.9 Segment

Aquatic Feature	Area Sum (acres)
Wetland, Emergent (PEM)	32.27
Wetland, Scrub-Shrub (PSS)	0.63
Wetland, Aquatic Bed (PAB)	-
Irrigation Canal, open water	98.83
River, Waters of the U.S.	-
Total Area of Aquatic Resources	**46.1**

MP 25.9 (Drop 1) to MP 28.1 (Drop 5)

Five drop structures at the end of the Canal create pools and backwater features that are conducive to forming wetlands. At the bottom of Drop 1, a large pool exists that has adjacent wetland habitat (see Photo D1-10). The series of drop structures and Canal are located within a natural drainage and, accordingly, wetlands exist throughout this drainage (see Photo D1-11). At the end of the Canal, the recently reconstructed Drop 5 discharges into the North Fork Milk River. A summary of aquatic resources within this survey area segment is provided in Table D1-7.

Photo D1-10. Wetlands adjacent to the pond formed at the bottom of Drop 1, looking north.

Photo D1-11. Wetlands along the Canal between Drops 4 and 5, looking south.

Table D1-7. Summary of Aquatic Resources within the MP 25.9 to MP 28.1 Segment

Aquatic Feature	Area Sum (acres)
Wetland, Emergent (PEM)	6.12
Wetland, Scrub-Shrub (PSS)	-
Wetland, Aquatic Bed (PAB)	-
Irrigation Canal, open water	30.12
River, Waters of the U.S.	0.89
Total Area of Aquatic Resources	**37.13**

D1.3 Wetland Reconnaissance Mapping

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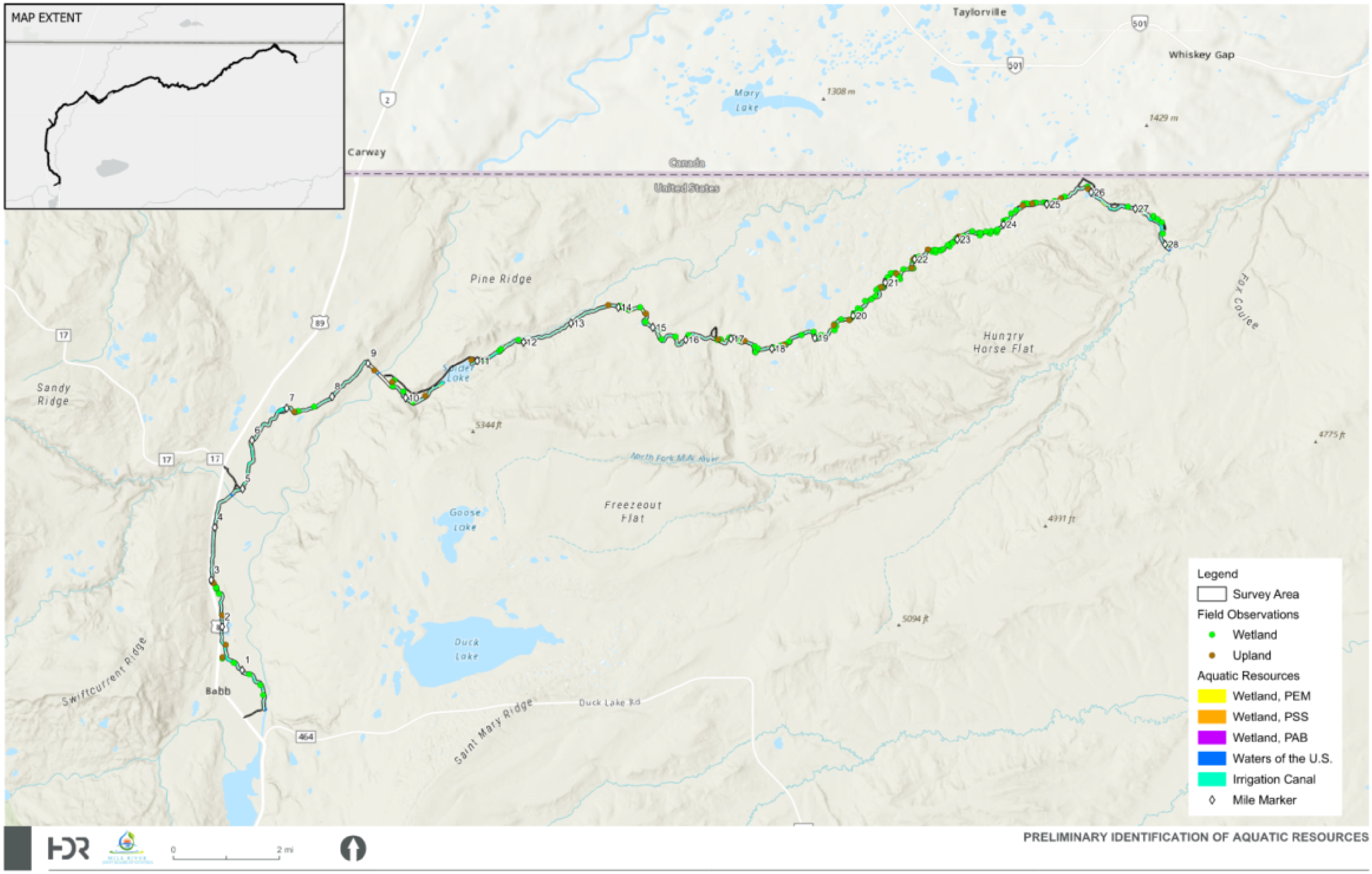

Figure 1-1. Preliminary Identification of Aquatic Resources (Overview)

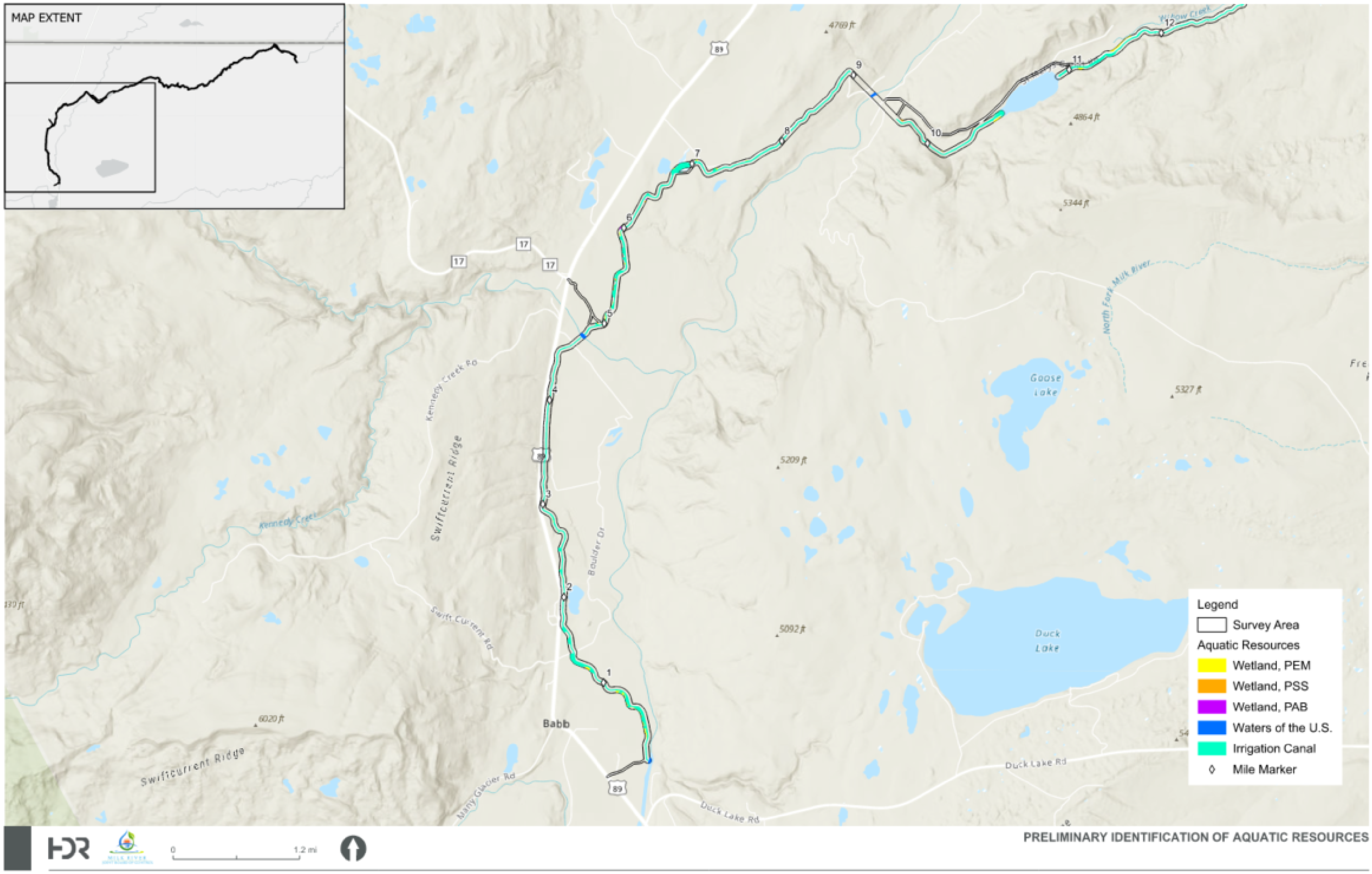

Figure 1-2. Preliminary Identification of Aquatic Resources (1 of 3)

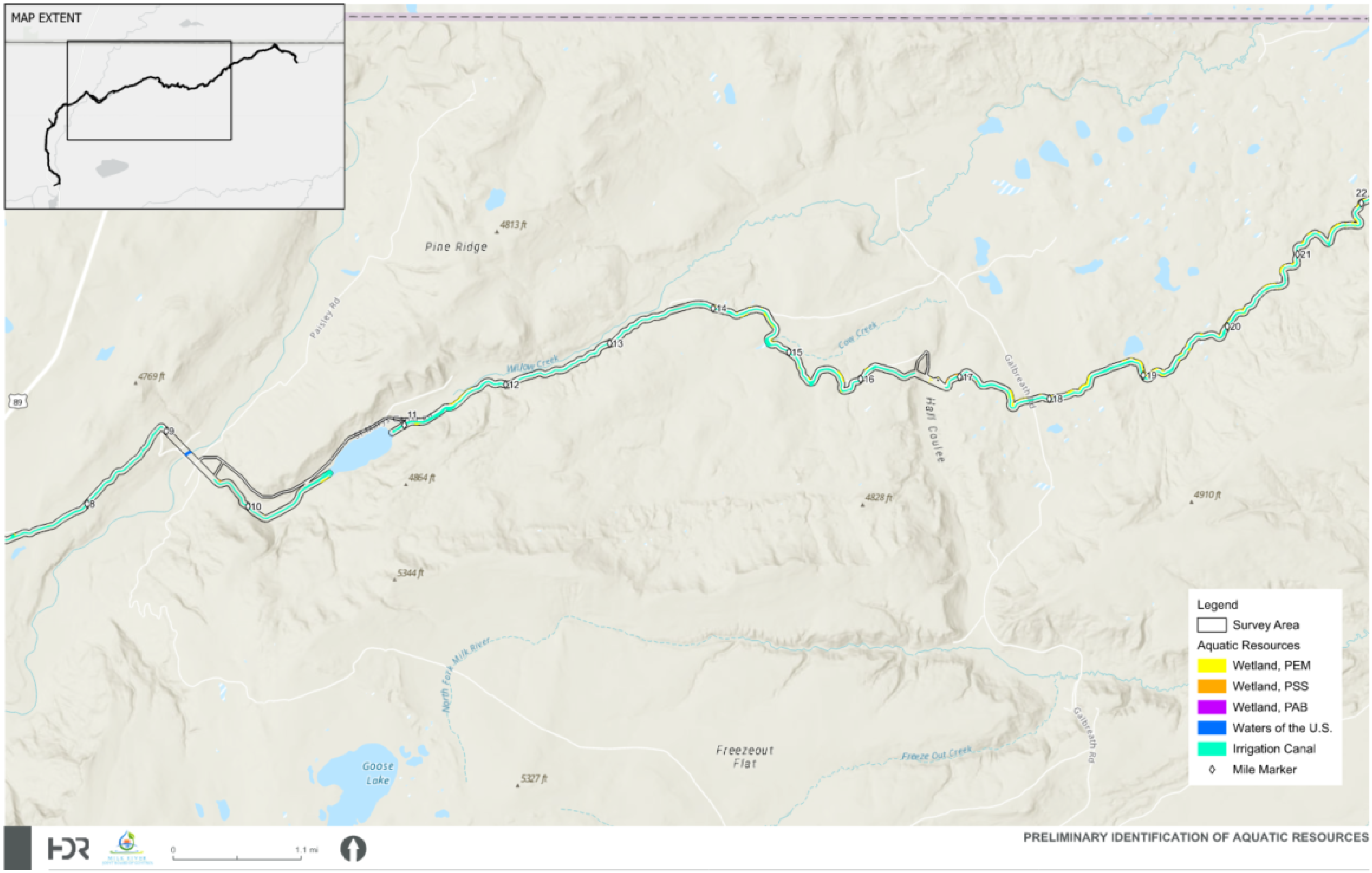

Figure 1-3. Preliminary Identification of Aquatic Resources (2 of 3)

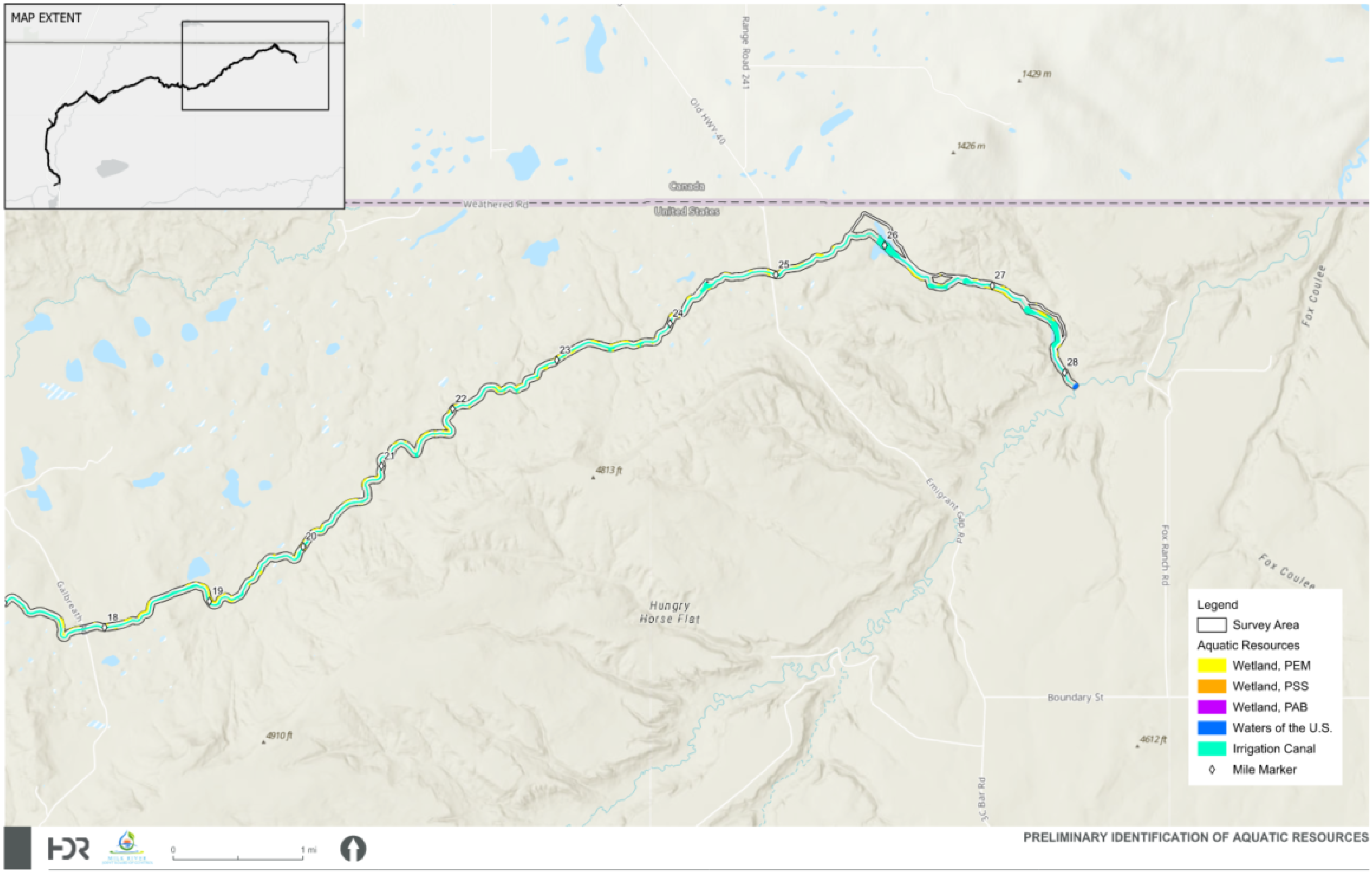

Figure 1-4. Preliminary Identification of Aquatic Resources (3 of 3)

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Appendix D2. Hydrogeology Memo

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Hydrogeology Memo

	Project File
From:	Gregg Jones, PhD, PG, HDR
Project:	Milk River and St. Mary River Watersheds Plan-EIS
Date:	Friday, July 12, 2024

D2.1 Introduction

This memorandum is a technical review of the hydrogeologic properties in the St. Mary Canal project area and the potential effects on resources dependent on hydrogeology that may be affected by each alternative. Elements of the review include:

- Hydrogeologic Analysis
- Seepage Analysis
- Wetlands, Springs, and Streams Analysis
- Summary and Conclusions

D2.2 Hydrogeologic Analysis

Aquifers in the area are classified as either unconsolidated-deposit aquifers or bedrock aquifers. The area's general hydrogeologic setting is fine-grained, low-permeability bedrock aquifers overlain in many areas by relatively thin, unconsolidated-deposit aquifers of moderate to high permeability. Groundwater from both types of aquifers is used mainly for minor stock watering and domestic supply purposes (Canon 1996).

D2.2.1 Bedrock Aquifers

The project area lies within a structurally complex area known as the disturbed belt (Mudge and Earhart 1980), which is a zone of closely spaced, westward dipping thrust faults with many folds and some normal faults. All bedrock units exposed in this area are sedimentary in origin and range in age from late Cretaceous to early Tertiary. Bedrock formations traversed by the canal from west to east are shown in Figure D2-1 and described in Table D2-1. Each colored polygon denotes a different formation and has an associated lettered designation, such as Ktm for the Two-Medicine formation.

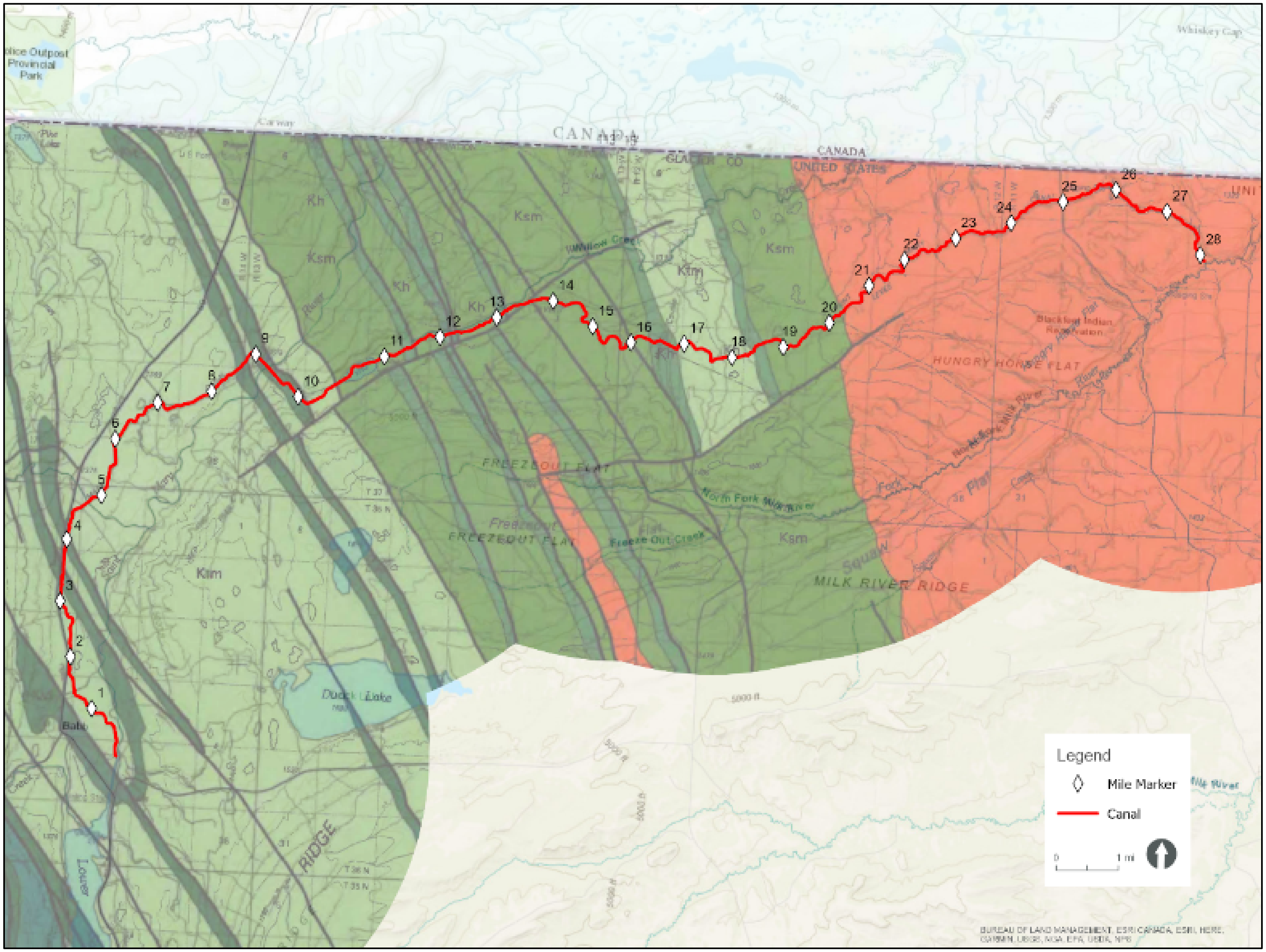
Within the disturbed belt, rocks typically dip from 20 to 60 degrees westward, although in many locations, highly disturbed rocks have steeper or shallower dips or are overturned. Bedrock aquifers are found primarily in the Cretaceous mudstone and sandstone beds of the formations listed in Table D2-1. These aquifers are tapped by wells only in the vicinity of their outcrops or where they are overlain by thin, unconsolidated deposits that are generally more productive. In fact, for most wells drilled in the Disturbed Belt, the upper 100 to 150 feet of the well is most productive, with little or no additional well yield gained by drilling to greater depths (Canon 1996). Groundwater is generally not available, or water quality is not satisfactory for domestic use in the mudstone or soft shale beds of the Willow Creek formation, St. Mary's River Formation, or the upper part of the Two-Medicine formation (Canon 1996).

Annual recharge to bedrock aquifers is limited by the relatively low permeability of the mostly fine-grained bedrock and is minimal compared to that of the more surficial unconsolidated aquifers. Bedrock aquifers may discharge water to major streams, but this is not quantified in the literature and likely represents a small percentage of total water exchange between surface water bodies and the groundwater system in the project area. Due to this, it is reasonable to assume that the amount of water lost from the canal to the bedrock units through seepage is minimal, and when it does occur, it is not transmitted more than a few thousand feet away from the project area before remerging in surface water features or entering unconsolidated aquifers.

Table D2-1. Bedrock Formations Traversed by the Canal from West to East (Canon 1996).

Formation	Canal Mile	Map Symbol	Description	Water-Bearing Characteristics
Two-Medicine	0 – 10	Ktm	Mudstone with some sandstone.	Mudstone in the upper portion of the formation produces little to no water.
St. Mary's River	10 – 20	Ksm	Mostly mudstone interbedded with thin beds of fine-grained sandstone.	In general, the formation yields little water to stock or domestic wells.
Willow Creek	20 – 28	Tkw	Variegated clay and soft sandstone with local lenses of purple-gray limestone.	Formation is not considered to be an aquifer although a few wells yield from 1 to 10 gpm. Overall, not suitable for stock or domestic water supplies.

Figure D2-1. Bedrock Geologic Formations Traversed by the Canal



Source: Canon 1996

D2.2.2 Unconsolidated-Deposit Aquifers

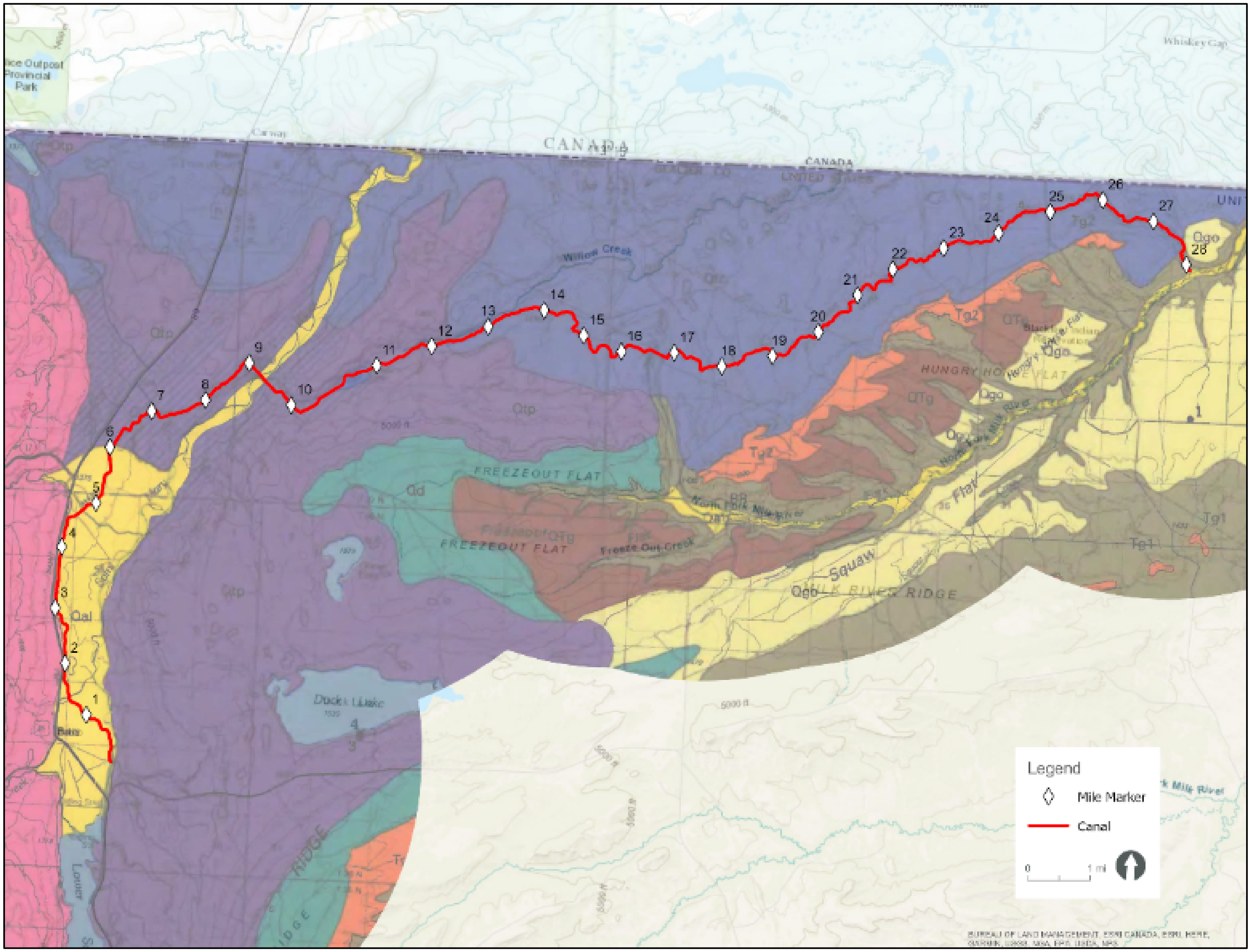
The bedrock units described above are overlain by unconsolidated deposits of Quaternary age or, in some areas, by gravel of late-Tertiary age. These deposits contain the most important aquifers in the vicinity of the project area. Unconsolidated deposits include gravel in terraces and pediments, till from continental ice sheets and mountain glaciers, sediments deposited in glacial lakes, rock and surficial debris in landslides, and alluvium in the channels and flood plains of many streams (Canon 1996). Unconsolidated-deposit aquifers traversed by the canal from west to east are shown in Figure D2-2. Each colored polygon denotes a different aquifer unit and has an accompanying lettered designation, such as Qal for the alluvium aquifer unit. Each of these units is described in Table D2-2. Alluvium gravel beds within or beneath till, gravel in pediments and terraces, and glacial outwash are all used as sources for stock and domestic water supplies. Where bedrock is unproductive mudstone or shale, unconsolidated deposits are the only source of potable groundwater. Recharge is greatest to unconsolidated-deposit aquifers in the western portion of the canal where precipitation is greatest. In these areas, gravel-capped pediments and terraces are readily recharged by percolation of rainfall and snowmelt (Canon 1996). Additionally, the Quaternary-aged alluvium that underlies the first 6 miles of the canal (Figure D2-2) represents the geologic unit with the highest potential for large well yields in the project area, as described in Table D2-2.

Discharge from unconsolidated aquifers to surface water bodies occurs frequently in the region, and springs are numerous along contacts between unconsolidated deposits and underlying bedrock. These contact-type springs demonstrate the greater permeability and, thus, higher amounts of groundwater circulation in the surficial unconsolidated aquifers compared to the bedrock. Because of this, discharge from these aquifers likely plays a significant role in maintaining the base flow of many streams in the region (Canon 1996). The discharge of groundwater into surface features also indicates that the subsurface flow paths in and around the project area are probably relatively short and provides evidence that seepage from the canal is not likely transmitted more than a few thousand feet before exiting the groundwater system.

Table D2-2. Unconsolidated-Deposit Aquifers Traversed by the Canal from West to East (Canon 1996).

Deposit	Symbol	Canal Mile	Description	Water-Bearing Characteristics
Alluvium	Qal	0 – 6	Alluvium. Unconsolidated gravel, sand, silt, and clay beneath floodplains of major streams and some outwash gravel from piedmont glaciers. Present around almost all stream channels on the reservation.	Thick alluvial deposits are a dependable source of water for domestic and stock wells, yielding 10 to 50 gpm. In the St. Mary area, thick alluvial deposits yield 100 gpm or more to some wells.
Till Deposited by Piedmont Glaciers.	Qtp	6 – 12	Gravelly to clayey till in moraines and gravel deposits in narrow buried channels and meltwater channels. Thickness typically from 1 to 15 feet. Till deposited by Piedmont glaciers covers much of the western and southern parts of the reservation.	Generally, a poor aquifer due to its low permeability. However, in some areas, gravel deposits between till units or underlying till are an important aquifer.
Till Deposited by Continental Ice Sheets	Qtc	13 – 28	Pebbly clay loam or loam till containing numerous granitic and metamorphic pebbles, cobbles, and boulders.	Clayey to loamy till has low permeability and yields little to no water to wells.

Figure D2-2. Unconsolidated Deposits Traversed by the Canal



Source: Canon 1996

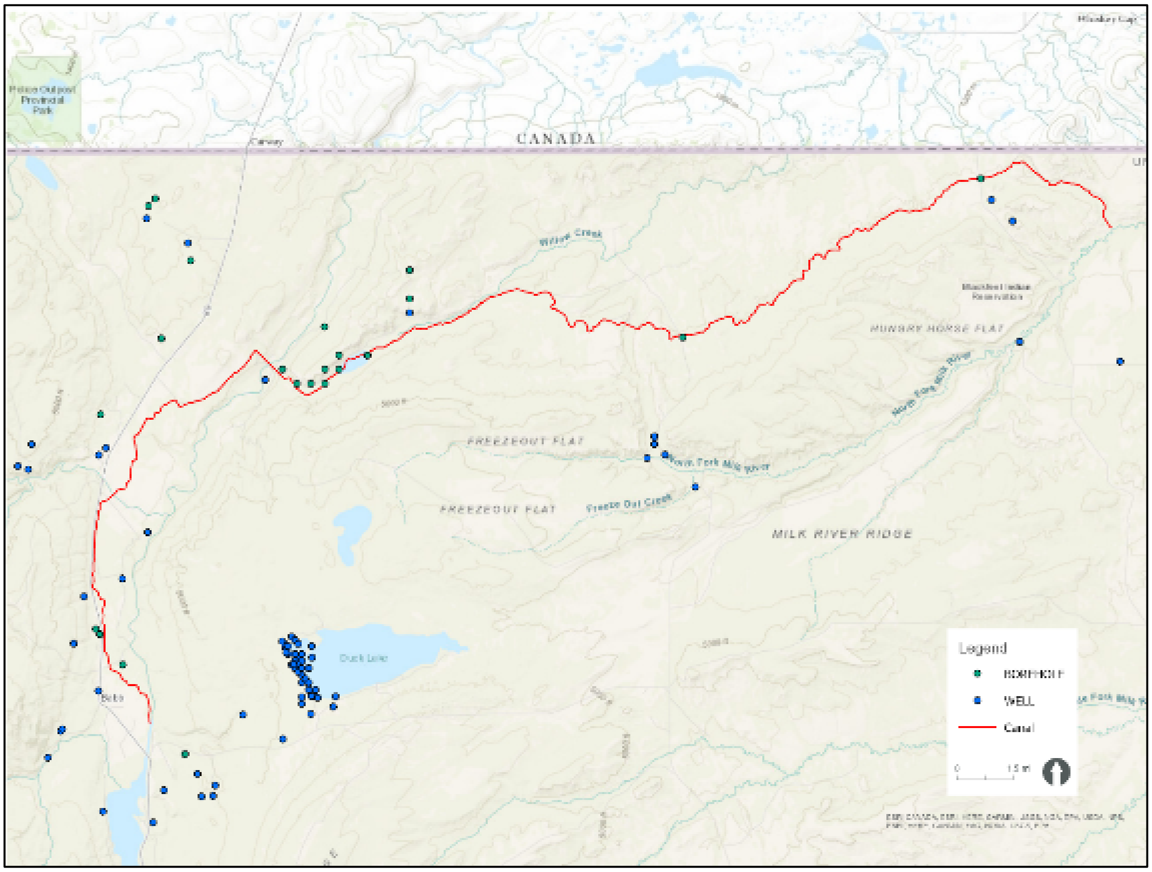
D2.2.3 Well Inventory and Lithologic Analysis

Logs for 18 wells and 11 borings located within approximately 2 miles of the canal were obtained from the Montana Bureau of Mines and Geology online web mapping application (Montana Bureau of Mines and Geology 2024). A 2-mile search radius was chosen because of the lateral variability of the geology in the region; the further a well is from the canal, the less likely the lithology it penetrates will be similar to the lithology that underlies the canal. Data from the logs is included in Appendix 1 and provides information on lithology, use, and yield.

Most of the 18 wells are identified for stock watering or domestic supply. The average depth of the wells, not including the borings, is 119 feet. Of the 18 wells, 11 penetrate only unconsolidated material, such as clay, silt, sand, gravel, and boulders, and do not extend into bedrock. There are some wells that do extend into the bedrock that exhibit relatively high production values, but whether this water comes from the bedrock units is unclear, as many of these are screened across both unconsolidated and bedrock units. Additionally, when available, well logs indicate that some of the wells in the vicinity of the canal are not screened near the ground surface. Since construction activities are likely to be limited to the first 10 feet below grade, impacts to the groundwater systems that supply these wells should be minimal.

Figure D2-3 shows the location of wells and test borings within 5 miles of the canal. A search radius of 5 miles was necessary as there are not many wells in the region, which reflects the sparse population and indicates that groundwater use is minimal. Along the canal, the density of wells decreases from west to east, which is expected, as the most productive unit in the project area (Qal in Table D2-2) underlies the western side. It should also be noted that the density of wells is less than it appears because many of the wells adjacent to the canal are shallow test borings drilled by the Montana Department of Transportation.

Figure D2-3. Location of Wells and Test Borings within Five Miles of the Canal



D2.2.4 Hydrogeologic Analysis Conclusions

As discussed above, bedrock in the vicinity of the canal has relatively low permeability, does not form significant regional aquifer systems, and likely does not supply significant quantities of water to wells. Unconsolidated-deposit aquifers are mostly low-permeability units, except for the alluvium in the western side of the project area (Figure D2-2). Wells are relatively shallow with an average depth of 119 feet and are mostly screened across unconsolidated material, such as clay, silt, sand, gravel, and boulders. This supports the aquifer characterizations that most groundwater is derived from shallow unconsolidated-deposit aquifers because water-bearing characteristics of bedrock aquifers are generally poor (Cannon 1996).

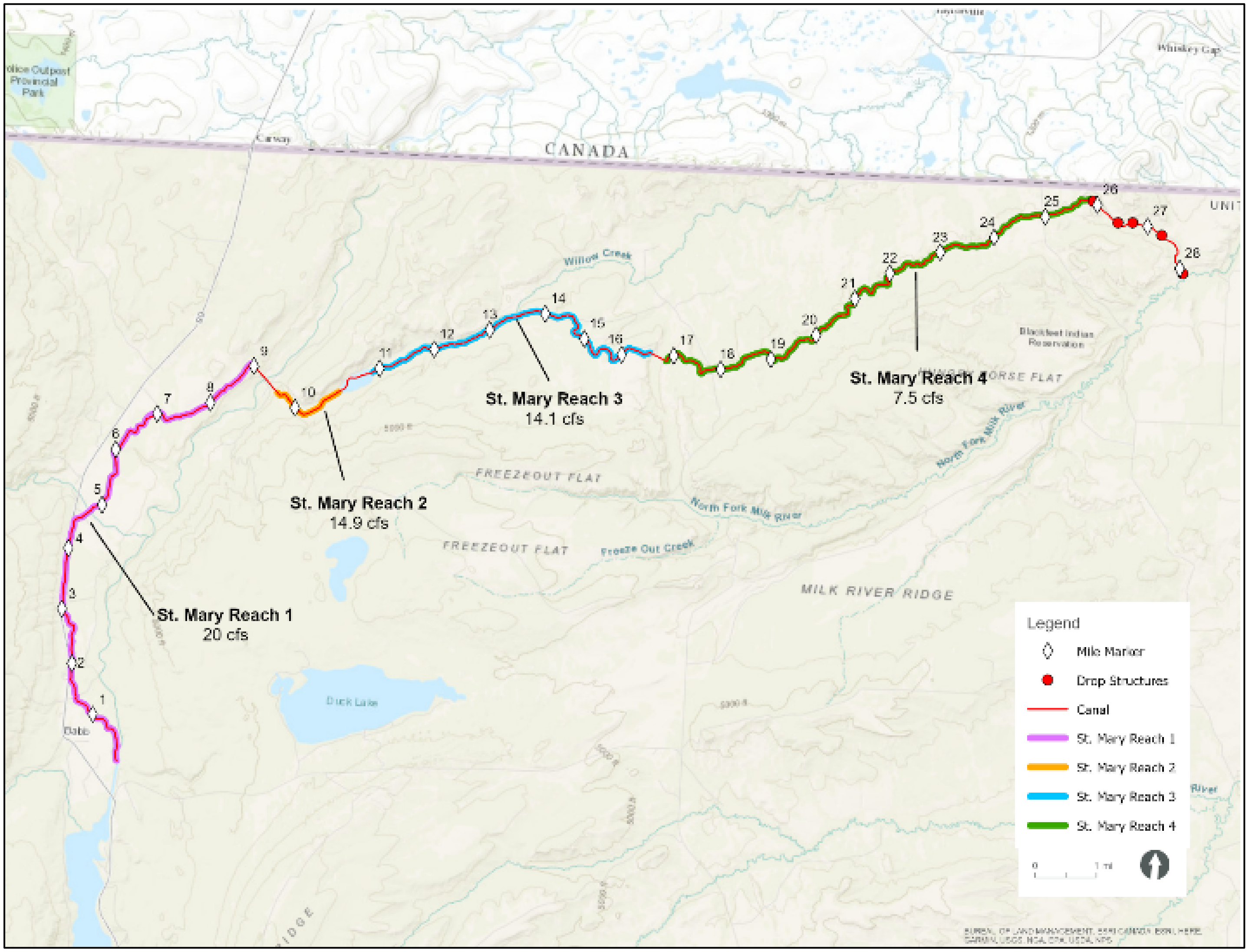
Flow paths in unconsolidated-deposit aquifers are relatively short because water is often discharged through springs at the exposed contacts with underlying low-permeability bedrock or to intersecting streams and rivers. This probably prevents the aquifers from transmitting water beyond several thousand feet of the canal through the groundwater system.

Pumped groundwater in the vicinity of the project area is used for domestic supply and stock watering. The density of domestic and stock watering wells, especially in the vicinity of the central and eastern portions of the canal, is so low that localized unconsolidated-deposit aquifers probably supply their small annual volumes. Additionally, when available, well logs indicate that wells in the 5-mile search radius of the canal are not screened near the ground surface. While channel reconstruction will have some influence on the groundwater system, changes should only occur close to the land surface and should not have an impact on groundwater well production.

D2.3 Seepage Analysis

Figure D2-4 exhibits total losses from the canal by reach and Table D2-3 shows loss percentages and rates by reach (HDR 2022). Evaporation rates are generally significantly less than seepage rates in canal systems (Mutema and Dhavu 2022), so most of these losses are expected to be through seepage to the shallow groundwater system. The first two reaches account for approximately 56.5 cubic feet per second (cfs) of loss (62 percent of the total) meaning that most of the loss occurs in the first 11 miles (42 percent of total) of the canal (Table D2-3). The canal only operates from March through September each year (Reclamation 2023), so changes to seepage into the shallow groundwater system will only occur during these times. A discussion of the effects of seepage on wetlands, springs, and streams within the project area is included in following section.

Figure D2-4. Seepage Losses from the Canal by Reach



Source: HDR 2022

Table D2-3. Seepage Loss Information by Reach

Reach	Reach Length (Miles)	Loss by Reach (CFS)	Loss by Reach (%)	Loss/Mile by Reach (CFS)
1	9.0	20.0	35.3	2.2
2	2.0	14.9	26.4	7.4
3	6.0	14.1	25.0	2.3
4	9.0	7.5	13.3	0.8
Total	**26.0**	**56.5**	**100.0**	**n/a**

Source: HDR, 2022

D2.3.1 Wetlands, Springs, and Streams Analysis

Figure D2-5 through Figure D2-7 exhibit the locations of National Wetland Inventory (NWI) wetlands near the canal and the 0.5-mile study area chosen to examine wetland effects. Additional information on the extent of wetlands along the canal is presented in Table D2-4. While no federal guidance exists that explicitly outlines criteria for delineating study areas with respect to wetland effect mitigation, area-specific guidance has been developed that defines “lateral effect distances” for specific soil types that are used for installing tile drainage systems in areas with wetlands. The area-specific guidance includes the prairie-pothole region, which spans across sections of Montana, North and South Dakota, Minnesota, Iowa (USDA 2016), and Nebraska (USGS 2022). The impacts to wetlands introduced by subsurface drainage systems have been studied previously (Tangen and Wiltermuth 2018), but studies into the effects on wetlands induced by canal reconstruction are lacking. It is reasonable to assume, however, that influences created by subsurface drainage systems will be similar to or greater than those introduced by canal reconstruction at similar depths, as newly installed drainage systems should impact shallow groundwater more significantly than altering the channel shape of an existing canal.

In the guidance documents referenced above, the van Schilfgaarde equation is used to calculate the minimum lateral distance from wetlands that drainage systems should be installed such that they will not deleteriously affect wetland hydrology. This equation does require the input of some site-specific data, including soil bulk density, drainable porosity, and saturated and residual water content, which can only be obtained directly through field investigations. However, while no wetland drainage guidance exists for Montana or its neighboring states, the Nebraska-specific guidance (USDA 2016) has estimated appropriate lateral effect distances for all soil series in the state, which are applicable to several installation depths for drainage systems. A simple query of all values calculated in the Nebraska guidance for the installation of a drainage system at a depth of 6 feet (the maximum depth analyzed herein), yields an average lateral effect distance of 306 feet, significantly smaller than 0.5 mile (2,640 feet). While values that exceed 0.5 mile do exist in this database (maximum value from all of Nebraska is 3,388 feet), such high values only occur for either soils that exist within wetlands or very poorly drained soils. Only five specific soil series of the 3,642 within the database exhibit a lateral effect distance larger than 0.5 mile. Additionally, most of the soils within the project area are defined as “well drained” by the web soil survey, and those that are defined as “poorly drained” or “very poorly drained” are generally within areas that are themselves wetlands. It is important to note that soil drainage is only one of several properties used to calculate lateral effect distance, and on its own does not provide sufficient information to understand how significantly wetlands within the project area will be affected by this work. However, considering the small number of instances values in the Nebraska-specific guidance that exceed 0.5 mile, and that most of the soils within the project area exhibit drainage characteristics that do not indicate extremely large lateral effect distances, it is unlikely that wetlands located further than 0.5 mile from the project area will be affected by canal reconstruction.

Figure D2-5. Wetlands near Canal in Reaches 1 and 2

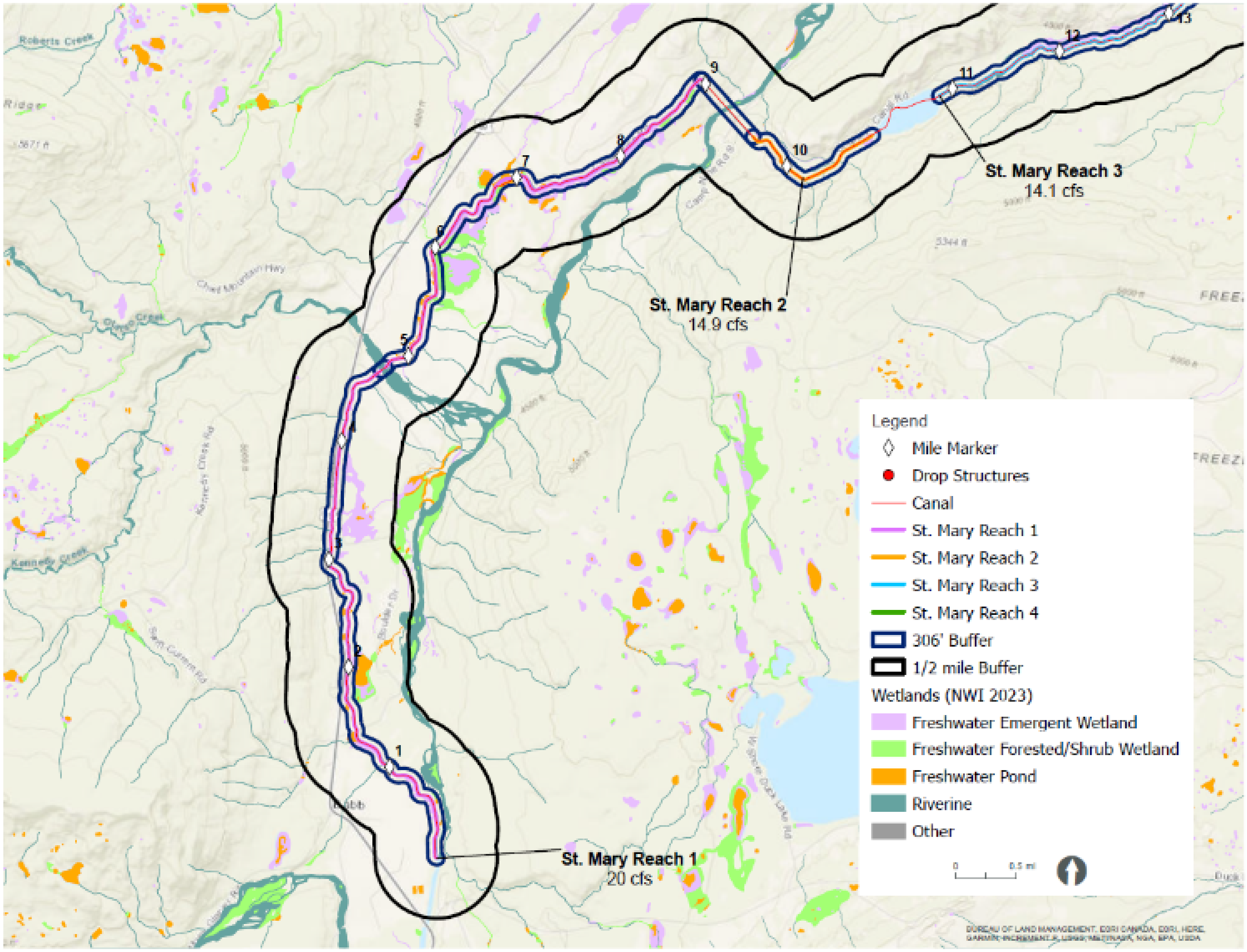


Figure D2-6. Wetlands near Canal in Reach 3

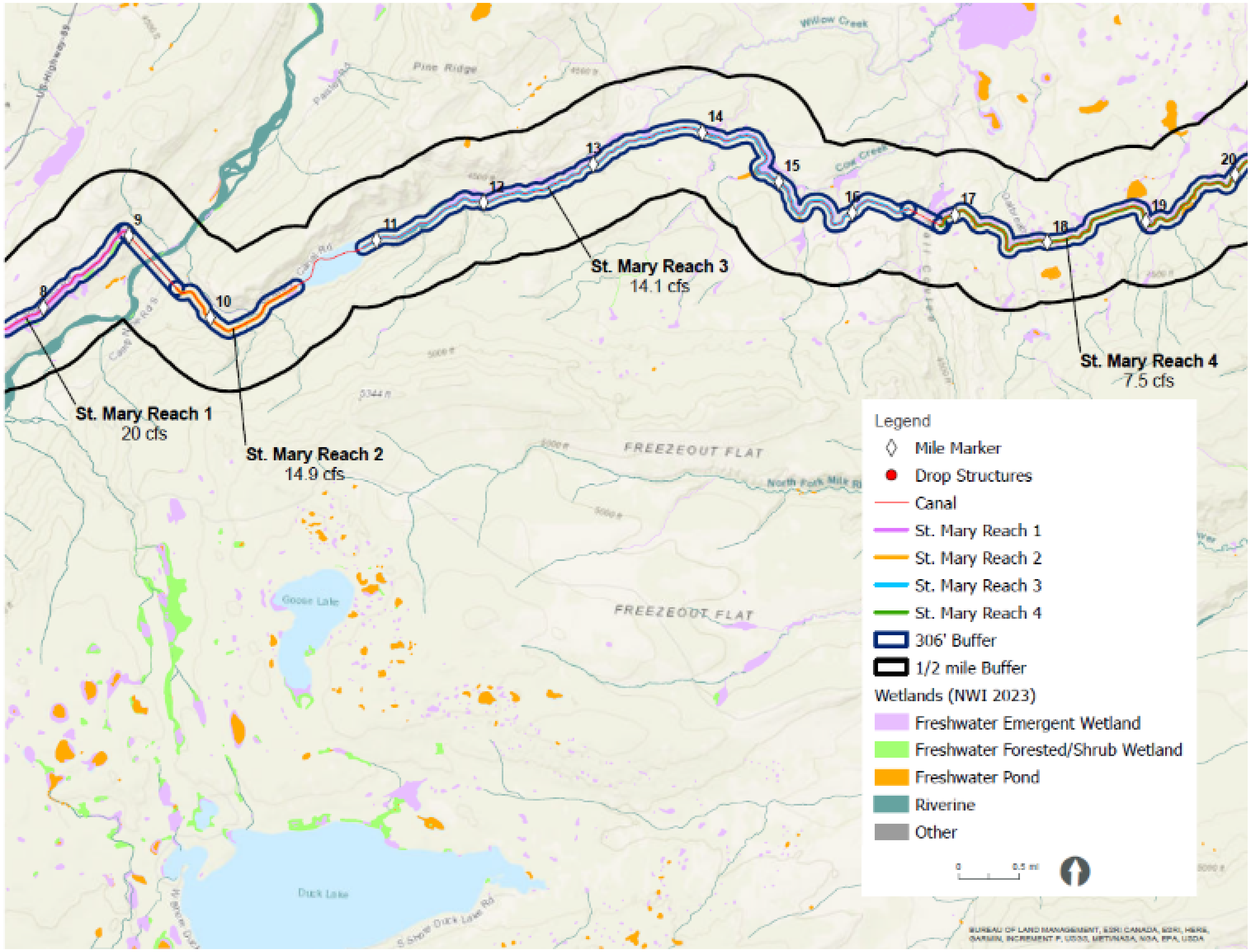


Figure D2-7. Wetlands near Canal in Reach 4

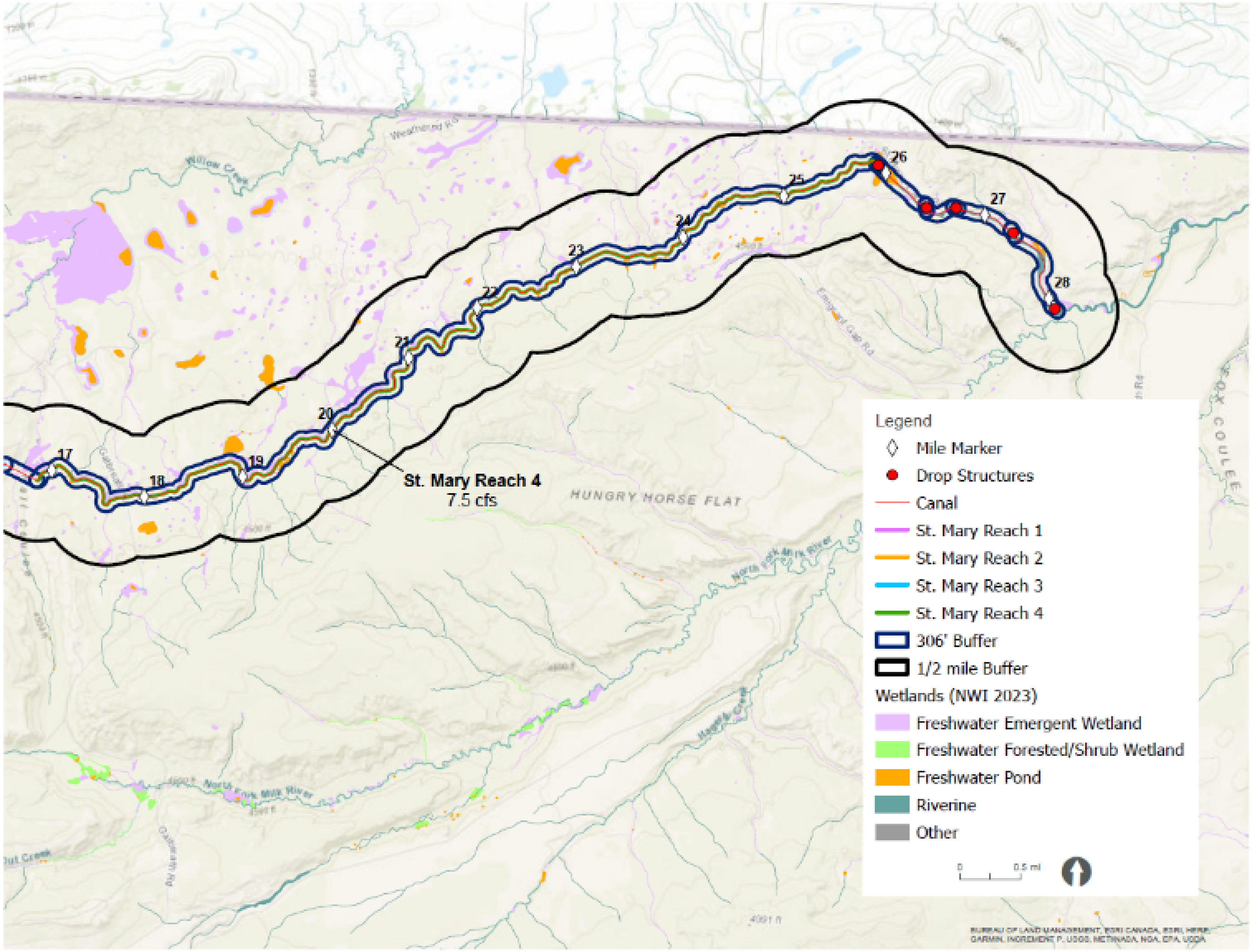


Table D2-4. Distribution of NWI Wetlands within 0.5 miles of the Canal by Reach

Reach	Miles	Wetland Acres by Reach	Wetlands Percent by Reach	Wetland Acres Per Mile
1	9	487.6	35.0	54.1
2	2	120.9	8.7	60.4
3	6	357.7	25.6	59.6
4	9	428.4	30.7	47.6
Total	**26**	**1,394.6**	**100.0**	**n/a**

Source: HDR, 2022. Calculations based on 2021 National Wetland Inventory (NWI) files obtained from USFWS.

It is likely, however, that wetlands within the 0.5-mile study area will be impacted. Table D2-4 identifies the distribution of wetlands within the study area for all four reaches of the canal, excluding the drop structures. Figure D2-5 through Figure D2-7 exhibit the mean lateral effect distance from the Nebraska-specific guidance as a buffer around the canal, showing that some wetlands in the project area would be expected to be impacted by newly installed irrigation systems based on these calculations. Of course, determining whether canal seepage significantly impacts the viability of specific wetlands in the project area requires additional, site-specific information and direct calculations of lateral effect distances, but this rough macro-analysis of all soil series in an entire state suggests that wetlands within these distances from the project area are likely influenced by canal seepage to a significant degree.

It is expected that canal seepage provides much of the water that sustains these wetlands due to the low permeability of the bedrock and short groundwater flow pathways discussed previously. The effect that seepage reductions may have on wetlands and the flow of nearby springs and streams is unknown but possibly ranges from reduction of extent to complete elimination. Many factors will determine the degree of impacts, including the magnitude of seepage reductions along each reach, the amount of surface runoff from each wetland, and the geology underlying the wetlands that determines the degree of infiltration. Some investigation has been performed to assess wetland impacts as a part of this project. Further information on their findings is available in Appendix C of the Project Environmental Impact Statement (USDA 2024).

D2.4 Summary and Conclusions

The following summarizes the degree to which proposed modifications to the canal that would reduce seepage losses may affect wells, wetlands, springs, and streams in the vicinity of the project area.

D2.4.1 Seepage Losses in the Vicinity of the Canal

There is approximately 56.5 cfs (112 ac ft/day) of loss across a 26-mile length of the canal (not including the 2 miles at the end that encompasses the drop structures) that is mostly attributable to seepage. More than 60 percent of the loss is in the first 11 miles of canal, with a relatively low loss rate (0.8 cfs per mile) in the final 9 miles.

D2.4.2 Wells

Aquifers in the area are classified as either unconsolidated-deposit aquifers or bedrock aquifers. The general hydrogeologic setting of the area is fine-grained, low-permeability bedrock aquifers overlain in many areas by relatively thin, unconsolidated-deposit aquifers of moderate to high permeability. Groundwater from both types of aquifers is used mainly for minor stock watering and domestic supply purposes.

The permeability of unconsolidated-deposit aquifers is mostly low, except for the alluvium underlying the first 6 miles of the canal. Flow paths in unconsolidated-deposit aquifers are relatively short because water discharges through springs at the contacts with the low-permeability bedrock or along streams and rivers. This prevents the aquifers from conveying water over significant distances. Bedrock aquifers in the vicinity of the canal have relatively low permeability and do not yield significant quantities of water to wells (Canon 1996). Wells within 2 miles of the canal are relatively shallow, with an average depth of 119 feet, and mostly penetrate unconsolidated-deposit aquifers composed of clay, silt, sand, gravel, and boulders. Few extend into bedrock aquifers. Well logs also indicate that the screened interval of some supply wells are not near the land surface, and the seepage restrictions caused by canal reconstruction is likely to only affect the groundwater system at surficial depths.

Most of wells in the vicinity of the canal probably obtain water from relatively localized unconsolidated-deposit aquifers that are recharged mainly by snowmelt. The wells may also obtain minor quantities of water from bedrock aquifers that are overlain by unconsolidated deposits. For the reasons discussed above, it is unlikely that wells in the region are supplied solely by seepage from the canal to a significant degree. Furthermore, the density of domestic and stock watering wells, especially in the vicinity of the central and eastern portions of the canal, is so low that localized unconsolidated-deposit aquifers probably supply their small annual volumes with no need for additional recharge from canal seepage losses.

D2.4.3 Wetlands, Springs, and Streams

The four reaches of the canal encompass significant acreages of adjacent NWI wetlands: approximately 1,400 acres within 0.5 mile of the canal. It is likely that canal seepage provides the majority of the water that sustains some of these wetlands. The wetlands are maintained because much of the water lost to seepage from the canal remains near the surface due to the low permeability of the underlying unconsolidated sediments and bedrock, which restricts infiltration into the subsurface and subsequent down-gradient flow.

The effect seepage reductions may have on wetlands and the flow of nearby springs and streams ranges from reduction of extent to complete elimination. There are many factors that could contribute to seepage reductions along each reach, including the amount of surface runoff from each wetland and the wetland’s underlying geology that determines the degree of infiltration. Investigations into wetland impacts have been performed as a part of this project. Their findings are available in Appendix C.

D2.5 References

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USDA. 2024. Watershed Plan – Environmental Impact Statement for the St. Mary Canal Modernization Project; *In Prep*; July 2024

Appendix 1. Wells and Test Borings Within 2 Miles of the Canal

Well #	Name	Well ID	S/T/R	Purpose	Geo Unit	Well Depth	Cased Depth & Diameter	Yield	Static Water Level	Well Log
1	Thronson's West Winds Cafe	90056	21/36N/14W		KVT	200	78-200 – 6" perf Casing	N/D		0-1 topsoil 1-10 gravels and boulders 10-50 gray sandstone 50-200 gray sandstone
2	Mt. Dept of HWYs St. Mary Canal #2	147598	22/36N/14W	Geotech Boring	KVT	56.5		N/D	21	0-45 brown dense gravel w/ coarse sand, silt, boulders 45-56.5 dark grey dense fine sand w/ some silt w/ boulders
3	Glacier Natl Pk Lodges	289527	16/36N/14W	Unused		200	0-20 8.8 20-200 6	N/D		0-1 topsoil 1-18 tan sandstone med hard 18-22 gray sandstone hard 22-155 gray sandstone hard 155-156 brown sandstone very hard 156-174 gray sandstone hard 174-200 black shale w/ gray sandstone lenses
4	Glacier Natl Pk Lodges	289523	16/36N/14W	Unused	KTM	220	6	N/D	15	1-19 topsoil 1-11 tan sandstone med hard 11-182 gray sandstone med hard 182-187 black shale med hard 187-190 gray sandstone hard

Well #	Name	Well ID	S/T/R	Purpose	Geo Unit	Well Depth	Cased Depth & Diameter	Yield	Static Water Level	Well Log
										190-198 black shale med hard 198-204 gray siltstone hard 204-208 black shale med hard 208-213 gray sandstone hard 213-220 black mudstone hard
5	Weil Gus	90055	16/36N/14W			100	6	N/D	48	0-2 topsoil 2-18 boulders & gravels 19-48 gravel & brown clay 48-64 fractured siltstone 68-100 siltstone
6	Rein Marvin	90054	10/36N/14W			94	1-94 6 93-94 6	N/D	ND	0-10 boulders, sand, clay 10-40 sand & gravel 40-85 sand, gravel, and water 85-94 sand, gravel, and water
7	Swingly, Alger	264245	34/37N/14W			63	-3-63 6 63-63 6	N/D	N/D	0-27 gravel, cobbles, sand 27-100 fine grained sandstone
8	Blackfeet Tribe	90480	34/37N/14W			27	0-27	N/D	22	1-3 soil, gravel mixed 3-2 loose gravel
9	Montana DOT	316049	30/37N/13W	Test Boring		11.5	8	N/A	ND	0-1 topsoil 1-2.5 sandy clay w/ silt & gravel

Well #	Name	Well ID	S/T/R	Purpose	Geo Unit	Well Depth	Cased Depth & Diameter	Yield	Static Water Level	Well Log
										2.5-4 silty sand w/ gravel 4-11.5 sandy clay w/ silt
10	Montana DOT	316050	30/37N/13W	Test Boring		26.5	8	N/A	23.7	0-3 topsoil 3-10.5 sandy clay 10.5-26.5 Moist gray shale
11	Montana DOT	316049	30/37N/13W	Test Boring		11.5	8	N/A	ND	0-1 topsoil 1-2.5 sandy clay 2.5-4 silty sand w/gravel 4-11.5 sandy clay w/ silt
12	Montana DOT	316052	29/37N/13W	Test Boring		11	8	N/A	ND	0.2 gravel 0.2-1.5 clay w/ sand 1.5-3 sandy clay 3-11 green to white silty sandstone
13	Montana DOT Spider Lake Rd	316054	29/37N/13W	Test Boring		11.5	8	N/A	ND	0-1.5 topsoil 1.5-7.5 silty clay 7.5-10 silt 10-11.5 silt
14	Mt DOT	316057	29/37/N/13W	Test Boring	Ksm	35	0-35 - 8	N/A	ND	0-2.5 silt w/gravel, stiff, moist, brown 2.5–15 sand, dense moist brown 15-18 silty sand dense, moist, brown 18-35 gray shale moist to wet
15	Montana DOT Spider Lake Rd	316059	20/37N/13W	Test Boring		26.5	8	N/A	ND	0-2 silt w/ gravel 2-18 silty clay 18-19 silty gravel

Well #	Name	Well ID	S/T/R	Purpose	Geo Unit	Well Depth	Cased Depth & Diameter	Yield	Static Water Level	Well Log
										19-26.5 silt
16	Montana DOT	316060	20/37N/13W	Test Boring		20.4	8	N/A	ND	0-5 topsoil 5-15 sandstone 15-17.5 silt w/gravel 17.5-20.4 sandstone
17	Montana DOT Spider Lake Rd	316062	21/37N/13W	Test Boring		16.5	8	N/D	N/A	0-1.5 topsoil 1.5-3.5 silty clay 3.5-7 silty clay 7-16.5 silty sand, sandstone
18	Dbl Bison Ranch	281159	21/37N/13W	Stock Watering		122	-2-54 8 44-94 6	100 gpm 11/hr	ND	0-2 topsoil 2-25 tan clay 25-86 gray shale 86-122 gray shale
19	Dbl T Bison Ranch	281160	16/37N/13W	Stock Watering	Kh	264	34-264 -8	2gpm 24/h	9	1-2 black topsoil 2-24 tan clays 24-148 dark gray sandstone 148-225 gray shale 225-264 dark gray to black sandstone
20	Dbl T Bison Ranch	281162	16/37N/13W	Stock Watering		166	0-40 10 40-166 8	1gpm 3.5hrs	12	0-2 topsoil 2-28 tan, brown clay 28-62 gray, black sandstone 62-88 gray shale 88-120 gray shale 120-166 gray, black sandstone
21	North Fork Cattle Co	160731	32/37N/12W	Domestic		38	-2-38 6	30gpm 1.0hr	8.6	0-12 topsoil sand gravel 12-15 brown clay

Well #	Name	Well ID	S/T/R	Purpose	Geo Unit	Well Depth	Cased Depth & Diameter	Yield	Static Water Level	Well Log
										15-28 sand, gravel, water 28-33 brown clay 33-40 sand gravel
22	N Fork Cattle Co.	160730	32/37N/12W	Domestic		141	-2-141 6 106-115 6	35gpm 1.0hr	61	0-14 tan clay, gravel 14-89 shale seams of clay & gravel 89-141 gray shale
23	N. Fork Cattle Co.	166234	32/37N/12W	Domestic		100	-2-22 6 13-100	10gpm 1.0hr	25	0-16 silt sand gravel 16-76 hard gray shale 76-100 gray shale w/ seams
24	N Fork Cattle Co.	205980	32/37N/12W	Domestic		86	-2-18 6 16-86 4	35gpm 1.0hr	50	0-1 topsoil 1-3 tan clay w/small gravel 3-71 gray shale 71-81 gray shale
25	MDOT	137712	20/37N/12W	Boring	Ktm	61.5	N/D	N/D	40	0-15 clay medium to stiff brown clay 15-16.5 hard layer 16.5-47 clay still to very stiff 47-53 clay hard brown w/ some gravel & sand 53-61.5 clay hard gray some silt and gravel
26	MDOT	137710	6/37N/11W	Boring		61.5	N/D	N/D	50	0-2.5 sand, gravel, clay 2.5-9 silt w/ some clay & sand

Well #	Name	Well ID	S/T/R	Purpose	Geo Unit	Well Depth	Cased Depth & Diameter	Yield	Static Water Level	Well Log
										9-61.5 clay, silt, sand, gravel
27	Art Dresen	90475	8/37N/11W	Domestic		75	-2-75 4	10gpm 1.5hrs	8	0-20 soil 20-60 gravel 60-75 gray clay
28	Rumney William	90477	20/37N/11W	Stockwater		39	7	40gpm 3hrs	19	0-20 topsoil & clay 20-39 sand & gravel
29	Johnson Walter	90478	22/37N/11W	Domestic, Stockwater		35	5	5gpm	27	0-0.5 topsoil 0.5-6 cement stone 6-12 clay 12-18 gravel 18-25 clay 25-29 gravel 29-35 clay

N/D – No data

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Appendix D3. Alternative Analysis

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Alternative Analysis

To:	NRCS
From:	HDR, Inc.
Project:	Milk River and St. Mary River Watersheds Plan- Environmental Impact Statement
Date:	July 2023 (October 2025)

D3.1 Introduction

This technical memorandum documents alternatives formulation, screening, and development. Based on alternative screening, this memorandum documents data collection, watershed characteristics, modeling approaches, existing conditions, hydrologic and hydraulic modeling, and proposed management measures used to formulate alternatives analyzed in detail in the Watershed Plan-EIS.

D3.2 Alternatives Formulation

Extensive work with stakeholders and agencies over the last few decades has been on-going in both the St. Mary and Milk River Watersheds by federal, state, and local interests (such as the MRJBOC) to look at options on how to address the agricultural impact of unreliable St. Mary River water. This section documents the range of alternative developed and the criteria and results of screening.

D3.2.1 Alternatives Development and Screening

An initial range of alternatives were developed based on scoping and past federal, state, and local coordination. The range of alternatives considered are:

- Irrigation District Conveyance and On-Farm Efficiency Improvements - This alternative considers increasing the efficiency of the irrigation districts that are part of the Milk River Project as well as on-farm efficiency upgrades. Each irrigation district manages their own infrastructure which includes laterals, canals and other infrastructure. Efficiency improvements to this infrastructure could be made including the installation of Supervisory Control and Data Acquisition systems, piping, lining, etc. On-farm efficiency could include upgrading from less efficient sprinklers to more efficient sprinklers.
- Enhanced Freno Reservoir Storage - Sedimentation is decreasing the storage capacity of Fresno Reservoir, a component of the St. Mary Project, further reducing the amount of water that can be delivered to irrigators and other users. Increasing the storage capacity would increase water supply.
- Water Right Policy Amendments - In 1909, the Boundary Waters Treaty was signed between the United States and Great Britain. The purpose of the treaty was to prevent disputes regarding the use of boundary waters between the United States and Canada. The treaty noted that the St. Mary and Milk Rivers, and their tributaries in the state of

Montana and the provinces of Alberta and Saskatchewan, are to be treated as one stream for the purposes of irrigation and power, and the waters will be apportioned equally between the two countries, but in making such equal apportionment more than half may be taken from one river and less than half from the other by either country so as to afford a more beneficial use to each. It is further agreed that in the division of such waters during the irrigation season, between the 1st of April and 31st of October, inclusive, annually, the United States is entitled to a prior appropriation of 500 cfs of the waters of the Milk River, or so much of such amount as constitutes three-fourths of its natural flow, and that Canada is entitled to a prior appropriation of 500 cfs of the flow of the St. Mary River, or so much of such amount as constitutes three-fourths of its natural flow.

- Water Right Acquisition – Montana water right law is governed by the premise of “first in time, first in right”. Senior water rights to those of the irrigation districts of the MRJBOC have priority. MRJBOC purchase of senior waters would remove this priority.
- Reduction on Irrigated Acres – This alternative would involve changing cropping patterns from irrigated crops to non-irrigated crops. This would include changes in type of crops grown and/or other changes in agriculture use (row crops to range land, for example).
- Modernize the St. Mary Canal System – This alternative would include a host of measures to increase the efficiency of the canal system to maximize the full water right of St. Mary River water and therefore maximize delivery of water to Lake Fresno and ultimately the irrigation districts of the Milk River Project.
- No Action (as required by NEPA for comparison of alternatives) – This alternative would include continued operation and maintenance of the Milk River Project but would not increase the overall delivery of St. Mary River water nor the dependability of canal operations.

During the formulation phase, alternatives were evaluated based on meeting both National Environmental Policy Act (NEPA) and environmental review requirements specific to NRCS federal investments in water resources projects (PR&G). According to NEPA, “agencies shall rigorously explore and objectively evaluate all reasonable alternatives” (40 C.F.R. 1502.14). Reasonable alternatives are those that are technically and economically feasible and meet the purpose and need for the proposed action (40 C.F.R 1508.1). The purpose of proposed action is to alleviate damages to irrigated agriculture and agricultural communities served by the Milk River Project due to unreliable access to St. Mary River water. The project is needed to deliver fully allocated St. Mary River water for Milk River Project Beneficiaries to minimize agricultural damages and address the unreliable access to St. Mary River water.

According to PR&G DM9500-013, alternatives should reflect a range of scales and management measures and be evaluated against the Federal Objective and Guiding Principles; against the extent to which they address the problems and opportunities identified in the purpose and need; and against the criteria of completeness, effectiveness, efficiency, and acceptability:

1. Completeness is the extent to which an alternative provides and accounts for all features, investments, and/or other actions necessary to realize the planned effects,

including any necessary actions by others. It does not necessarily mean that alternative actions need to be large in scope or scale.

2. Effectiveness is the extent to which an alternative alleviates the specified problems and achieves the specified opportunities.
3. Efficiency is the extent to which an alternative alleviates the specified problems and realizes the specified opportunities at the least cost.
4. Acceptability is the viability and appropriateness of an alternative from the perspective of the Nation's general public and consistency with existing federal laws, authorities, and public policies. It does not include local or regional preferences for particular solutions or political expediency.

Table D4.1 summarizes screening based on NEPA and PR&G criteria.

Table D3-1. Summary of Key Features Along the St. Mary Canal

Alternative	Reasonableness (NEPA)	PR&G (Completeness, Effectiveness, Efficiency, Acceptability)	Selected For Detailed Study
Irrigation District Conveyance and On-Farm efficiency	While conveyance and on-farm efficiency improvements would decrease diversion water shortages in all types of water years (dry, wet, average) (BOR Basin Study Reference), these measures still require a reliable access to St. Mary River water. Due to this linkage, this alternative does not meet the project's purpose and need.	While conveyance and on-farm efficiency improvements would decrease diversion water shortages in all types of water years (dry, wet, average) (BOR Basin Study Reference), these measures still require a reliable access to St. Mary River water. Due to this linkage, this alternative is not complete in that other actions are necessary to realize the planned effects nor is the alternative effective in addressing the project need.	No
Enhanced Fresno Reservoir Storage	While this alternative could increase the available storage of water, it requires reliable access to St. Mary River water. Due to this linkage, this alternative does not meet the project's purpose and need.	While this alternative could increase the available storage of water, it requires reliable access to St. Mary River water. Due to this linkage, this alternative is not complete since other actions are necessary to realize the planned effects nor is the alternative effective in addressing the project need.	No

Alternative	Reasonableness (NEPA)	PR&G (Completeness, Effectiveness, Efficiency, Acceptability)	Selected For Detailed Study
Water Right Policy Amendments	Amending international water rights to allow for more water entering the U.S is not reasonable due to the speculative nature of reaching an agreement with Canada.	Amending international water rights to allow for more water entering the U.S is not reasonable due to the speculative nature of reaching an agreement with Canada. For this reason, this alternative is not effective as it would not alleviate the project need.	No
Water Right Acquisition	Acquiring senior water rights in the quantity needed to alleviate the project need is not reasonable to occur due to the importance of water rights in this region. MRJBOC does not have the authority to require the sale of a senior water right. Therefore, this alternative does not meet the project purpose nor is reasonable.	Acquiring senior water rights in the quantity needed to alleviate the project need is not reasonable to occur due to the importance of water rights in this region. For this reason, this alternative is not effective as it would not alleviate the project need.	No
Reduction in Irrigated Acres	Reduction in irrigated acres in the quantity needed to address the project need would require wholesale changes in farming practices that would be voluntary. The MRJBOC does not have the ability to implement this alternative. Therefore, this alternative is not reasonable.	Reduction in irrigated acres in the quantity needed to address the project need would require wholesale changes in farming practices that would be voluntary. The MRJBOC does not have the ability to implement this alternative. Therefore, this alternative is not effective as it would not alleviate the project need.	No
Modernize the St. Mary Canal System	This alternative is reasonable as it would increase the reliability and quantity of St. Mary River water delivery and help to alleviate agricultural damages associated with unreliable St. Mary River water supply.	This alternative would increase the reliability and quantity of St. Mary River water delivery and help to alleviate agricultural damages associated with unreliable St. Mary River water supply. This alternative is complete,	Yes

Alternative	Reasonableness (NEPA)	PR&G (Completeness, Effectiveness, Efficiency, Acceptability)	Selected For Detailed Study
		effective, efficient, and acceptable.	
No Action	Not applicable	Not Applicable	Yes, as required by NEPA.

D3.2.2 Alternatives Carried Forward for Detailed Study

Based on screening of alternatives, the alternative of Modernizing the St. Mary Canal System advanced for detailed study. To fully develop the alternative, the identification and subsequent screening of measures was performed. Screening of measures used the same NEPA and PR&G criteria as used for screening of alternatives. The following sections provides information on the conditions of the existing St. Mary Canal System and the development and screening of measures used to establish alternatives of Modernizing the St. Mary Canal System.

D3.3 Existing Conditions of the St. Mary Canal System

The existing conditions of the St. Mary Canal System was simulated using the topographic data described in the 2022 System Improvement Plan Report and the structural information described in the as-builts made available by Reclamation. Information describing the bridges and culverts was implemented based on the as-builts. It should be noted that HEC-RAS is incapable of representing the geometry of the siphons and the model can only define linear culverts. Hence, the Manning's values of the siphons were altered to account for the additional head losses associated with the bends of the siphons.

D3.3.1 Hydraulic Modeling

The St. Mary Canal System from immediately downstream of the St. Mary Diversion to the North Fork of the Milk River (approximately 29 miles) was analyzed using the one-dimensional (1D) capabilities of HEC-RAS, Version 6.2. To develop the 1D models, cross sections were placed using the RAS Mapper interface. Cross sections were aligned perpendicular to flow and along assumed equipotential lines. Cross sections are located at key locations along the canal, including slope breaks, changes in the cross-section shape (ponds and channel changes), and structures within the canal.

Model Extent

The model extents for analyzing the existing St. Mary Canal System and the reviewed improvements extended from immediately downstream of the St. Mary Diversion to the North Fork of the Milk River for a total extent of approximately 29 miles. In addition to the canal extent, the models also represented the major hydraulic structures along the length of the reach. These structures are detailed in Table D3-2.

Table D3-2. Summary of Key Features Along the St. Mary Canal System

River Station (ft)	Feature	Description
4	Downstream Study Limit	Furthest downstream extent of the model – Downstream study limit at the confluence with the North Fork of the Milk River
271	Drop 5	Hydraulic control for Drop 5
4544	Drop 4	Hydraulic control for Drop 4
7313	Drop 3	Hydraulic control for Drop 3
8893	Drop 2	Hydraulic control for Drop 2
11734	Drop 1	Hydraulic control for Drop 1
16681	Emigrant Gap Road	80’ single span bridge
54464	Whiskey Gap Road	80’ single span bridge
60589	Halls Coulee Siphon	Double barrel 78” smooth steel siphon culvert
65050	Halls Coulee Wasteway	Inoperable overflow control structure
86038	DeWolfe Ranch Access Bridge	75’ single span bridge
91296	Spider Lake Control Structure	Abandoned control structure, modeled as 27’ single span bridge Spider Lake located upstream.
103514	St. Mary Siphon	Double barrel 90” smooth steel siphon culvert
115445	Powell Bridge / Memorial Bridge	90’ single span bridge
126320	Powell Bridge	Bridge with three 9’x9’ radial gates
127400	Kennedy Creek Crossing	8.5’ x 9.25’ horseshoe (modeled as an 8.5’ x 9.25’ arch)
128007	Reid Ranch Access Bridge	80’ double span bridge with an 8” pier
144894	Boulder Drive / Babb Bridge	60’ three span bridge with 16” piers
152335	Upstream Study Limits	Furthest upstream extent of the model – Upstream study limit immediately downstream of the St. Mary Diversion

Boundary Conditions

Model simulations were run using constant discharges of 600 cfs and 850 cfs as these were identified as the current operating discharge and the design discharge. External boundary conditions were applied at the upstream and downstream extent of the model and remained the same between the existing and alternative conditions runs. A constant flow rate was specified at the upstream external boundary condition, while a normal depth calculation was used for the downstream boundary. A downstream normal depth boundary condition rating curve was developed using the existing terrain, assuming a downstream slope of 0.0001 ft/ft (0.001%) as this approximates the flat slope in grade and energy below Drop Structure 5.

D3.3.2 System Overview

Most of the Milk River flow utilized by irrigators, municipalities, and for recreational and wildlife benefits is diverted from the St. Mary River Watershed near Glacier National Park into the North

Fork of the Milk River via a 115-year-old, 29-mile-long facility. Components of the St. Mary Canal System include a diversion dam, canal headgates, three inverted siphons, check structures, five hydraulic drop structures, and approximately 29 miles of canal. The diversion facilities are owned and operated by Reclamation.

Besides the potential economic impacts to irrigators (over 140,000 acres) and the State of Montana, the loss of diverted water to the Milk River Basin would also detrimentally impact the following:

- Municipalities that depend on the Milk River as a source of drinking water,
- Ft. Belknap Indian Nation Reserved Water Rights Compact, which is contingent on diverted water,
- State and Federal wildlife refuges and preserves,
- Recreational and fishing facilities along the Milk River and related storage reservoirs,
- Numerous endangered, threatened, and proposed species, and
- Missouri River flows below the mouth of the Milk River.

Continued degradation of the diversion and conveyance system has resulted in a diminished capacity over the past century. Originally designed to deliver 850 cfs of water during the irrigation season, current capacity is estimated at 600 to 650 cfs. Deterioration of the facilities and lack of modernization further impacts operating efficiency and diversion opportunity. Annual water shortages in the Milk River Watershed have been well documented. Reclamation and the Montana Department of Natural Resources and Conservation (DNRC) both agree that modernization of the St. Mary Diversion and St. Mary Canal System back to its original capacity would significantly reduce these shortages (Montana Department of Natural Resources and Conservation, and Thomas, Dean & Hoskins, Inc., 2005). The diversion facilities lie entirely within the boundaries of the Blackfeet Nation, and as such, they are an important stakeholder.

St Mary River Diversion Structure

The St. Mary Diversion Dam and headgates (Figure D3-1 and Figure D3-2) are located approximately 1 mile downstream from Lower St. Mary Lake. Originally constructed in 1910, these structures were designed to divert water from the St. Mary River into the St. Mary Canal System. The diversion dam is a 6-foot-high concrete weir and sluiceway, 198 feet in length, and equipped with mechanically operated sluice gates installed in 1995.

Figure D3-1. St. Mary Diversion Structure[1]

Figure D3-2. St. Mary Diversion Structure Headgates

Historically, both structures have negatively impacted tribal fishery resources. The diversion dam acts as a barrier to upstream fish migration, and a significant number of fish become entrained in the canal through the headgates during the irrigation season (Montana Department of Natural Resources and Conservation, and Thomas, Dean & Hoskins, Inc., 2006).

Recent Update:

Reclamation has recently reconstructed the diversion structure and installed a modern fish ladder to improve fish passage and address aging infrastructure. The updated design includes

[1] Unless otherwise noted, all photos by HDR Engineering, Inc.

structural enhancements to the dam and headgates, improved flow control mechanisms, and fish-friendly features aimed at reducing entrainment and supporting native fish populations. These upgrades are part of a broader effort to balance irrigation needs with ecological restoration and tribal resource protection.

St. Mary Canal System Conveyance

The St. Mary Canal System was constructed between 1907 and 1915 with a design capacity of 850 cfs. The 29-mile canal portions are earthen, unlined, one-bank, contour design. The current canal capacity is approximately 600 to 650 cfs primarily due to slope instabilities and landslides. Originally, the prism consisted of a 26-foot bottom trapezoidal section with 2:1 (H:V) fill slopes and 1.5:1 cut slopes. The invert slope is approximately 0.0001 ft/ft or 0.53 ft per mile.

St. Mary River Siphon

Recently, Reclamation undertook an emergency replacement of the St. Mary Siphon during the summer of 2025, to be fully completed in 2026, following a catastrophic failure of the existing siphon. The original siphons were replaced with two 90-inch steel barrels which span the valley from the inlet to the outlet. The barrels are approximately 3,200 feet in length and discharge of each barrel is 425 cfs.

The St. Mary River Siphon was previously two, 90-inch riveted steel barrels that traverse the valley from the inlet, transition down to two, 84-inch steel barrels at the St. Mary River crossing, transition back to two 90-inch steel barrels and traverse up the valley slope to the outlet. The barrels were approximately 3,200 feet in length. The discharge of each barrel is approximately 425 cfs at a velocity of 9.63 feet per second in the two 90-inch section and 11.05 feet per second in the 84-inch section.

During the irrigation season while the St. Mary Canal System was in operation there were visible leaks in the steel barrels (Figure D3-3 and Figure D3-4). With the reconstruction these leaks are no longer an issue.

Figure D3-3. St. Mary Siphon Leaking Steel Barrels

Figure D3-4. St. Mary Siphon Leaking Steel Barrels

Halls Coulee Siphons

The Halls Coulee Siphon is under construction at the time of this report. Reclamation has begun a full replacement of the existing siphon. The replacement consists of two 78-inch diameter steel barrels that are approximately 1,405 feet long and span the broad valley at the existing siphon location.

The Halls Coulee Siphon was previously two riveted steel barrels, 6.5 feet in diameter and 1,405 feet in length, with concrete saddle supports. The twin barrels had a combined capacity of 850 cfs. Corrosion and weakened concrete saddle supports are visible along the reach of both barrels. Leaking barrels are also evident during the irrigation season (Figure D3-5 and Figure D3-6).

Figure D3-5. Halls Coulee Barrel Leak

Figure D3-6. Halls Coulee Saddle Support

Bridge Crossings

Bridge crossings provide access across the St. Mary Canal System without obstructing flow in the canal. The St. Mary Canal System includes multiple existing private and public bridge crossings along its extent. Existing St. Mary Canal bridge crossings are identified Table D3-3. Additional details on all bridge crossings, including pictures, are available in the *St. Mary Diversion Facilities Structural Evaluation of Canal Bridge Final Report* (Montana Department of Natural Resources and Conservation, and Thomas, Dean & Hoskins, Inc., 2007).

Table D3-3. Bridge Crossings

Existing Station	Name	Structure Type	Ownership
66+65	Babb County Road (BIA Route 313) Bridge	Cast-in-Place Concrete	Public
260+00	Kennedy Creek (Reid Ranch Access) Bridge	Precast Concrete Beams	Private
395+20	Powell (Memorial) Bridge	Steel Truss w/ Timber Deck	Private
501+00	St. Mary River Siphon Bridge	Steel Truss w/ Timber Deck	Private
670+00	DeWolfe Ranch Access Bridge	Railroad Trailer on Flat Car	Private
990+00	Martin (Whiskey Gap) Country Road Bridge	Precast Concrete Beams	Public
1375+00	Emigrant Gap County Road Bridge	Precast Concrete Beams	Public

Wasteways/Turnouts (Drains)

St. Mary Canal System wasteways serve as protective structures and facilitate the release of excess canal water from the canal and/or draining of the canal. Wasteways can also be designed with spillway crests or other means which may allow for automatically discharging excess canal water when the canal water level rises above a certain level.

For typical irrigation canals, turnouts (drains) serve to make irrigation water deliveries from the main canal to water users. The St. Mary Canal System serves as a conveyance canal, with no water users present along its extent (i.e., no designated irrigation or stock water deliveries are provided along its extent). As such, turnouts located along the St. Mary Canal System do not serve for making irrigation water deliveries but rather are used to provide drainage and release water from the canal during canal dewatering and maintenance and are also referred to interchangeably as drains for the purposes of this memo. Grass spillways identified in the *Milk River Project North Central Montana Feasibility Study* (Location Map) (U.S. Department of the Interior Bureau of Reclamation, 1999), are locations where the canal may overtop at vegetated sections of the Canal.

The St. Mary Canal System originally included two wasteway structures which were designed to release/discharge the canal design flow. One is located downstream of the Kennedy Creek Siphon and the second is located upstream of the Halls Coulee Siphon. Both were designed for the manual release of water from the canal via manually operated gates (are not designed for automatic spilling) and are not operational. The St. Mary Canal System includes four known turnouts, however, the *St. Mary Diversion Facilities Feasibility and Preliminary Engineering*

Report for Facility Rehabilitation[2] notes eight turnouts along the St. Mary Canal System. Existing St. Mary Canal wasteways and turnouts are identified below in Table D3-4 and Figure D3-7. Five grass spillways were identified in the Location Map prepared by Reclamation.

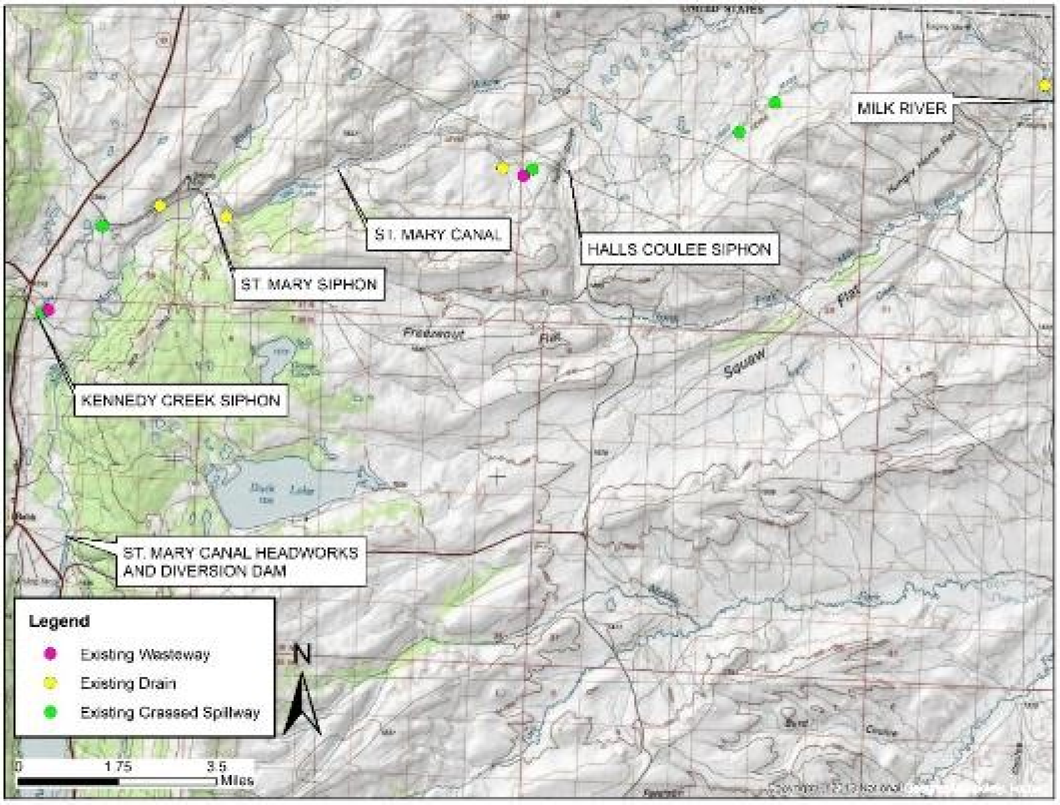
Table D3-4. St. Mary Canal Wasteways/Turnouts

Existing Station	Name	Structure Description	Notes
269+91	Grassed Spillway	Natural Grass Overflow Spillway	Unknown Capacity
277+20	Kennedy Creek Wasteway Structure[1]	Cast-in-Place Concrete Structure w/ 2 Radial Gates	Capacity for Canal design flow (Wasteway is not operational)
394+26	Grassed Spillway	Grass Overflow Spillway	Unknown Capacity
438+46	Turnout/Drain	Pipe with slide gate inlet	Unknown Capacity
532+53	Turnout/Drain	Pipe with slide gate inlet	Unknown Capacity
851+22	Turnout/Drain	Pipe with slide gate inlet	Unknown Capacity
884+93	Halls Coulee Wasteway	Cast-in-Place Concrete Structure w/ 3 Slide Gates and Baffled Apron Spillway	Capacity for Canal design flow (Wasteway is not operational)
901+78	Grassed Spillway	Grass Overflow Spillway	Unknown Capacity
1145+71	Grassed Spillway	Grass Overflow Spillway	Unknown Capacity
1205+32	Grassed Spillway	Grass Overflow Spillway	Unknown Capacity
1529+50	Turnout/Drain	Pipe with slide gate inlet	Unknown Capacity

1 Kennedy Creek Check Structure is located at Station 277+46 and is contiguous to the wasteway structure and operation. The Check Structure is comprised of a cast-in-place concrete structure with three radial gates.

[2] (Montana Department of Natural Resources and Conservation, and Thomas, Dean & Hoskins, Inc., 2006)

Figure D3-7. St. Mary Canal Wasteways and Turnouts



Underdrains (Culverts)

Underdrains (culverts) serve as protective structures to convey offsite surface drainage and runoff under the St. Mary Canal System to prevent additional water from entering the canal uncontrolled. The underdrains are located at major natural drainages to convey said surface drainage and runoff under the St. Mary Canal System. The St. Mary Canal includes seven major underdrain structures. The existing underdrains are identified in Table D3-5 and Figure D3-8.

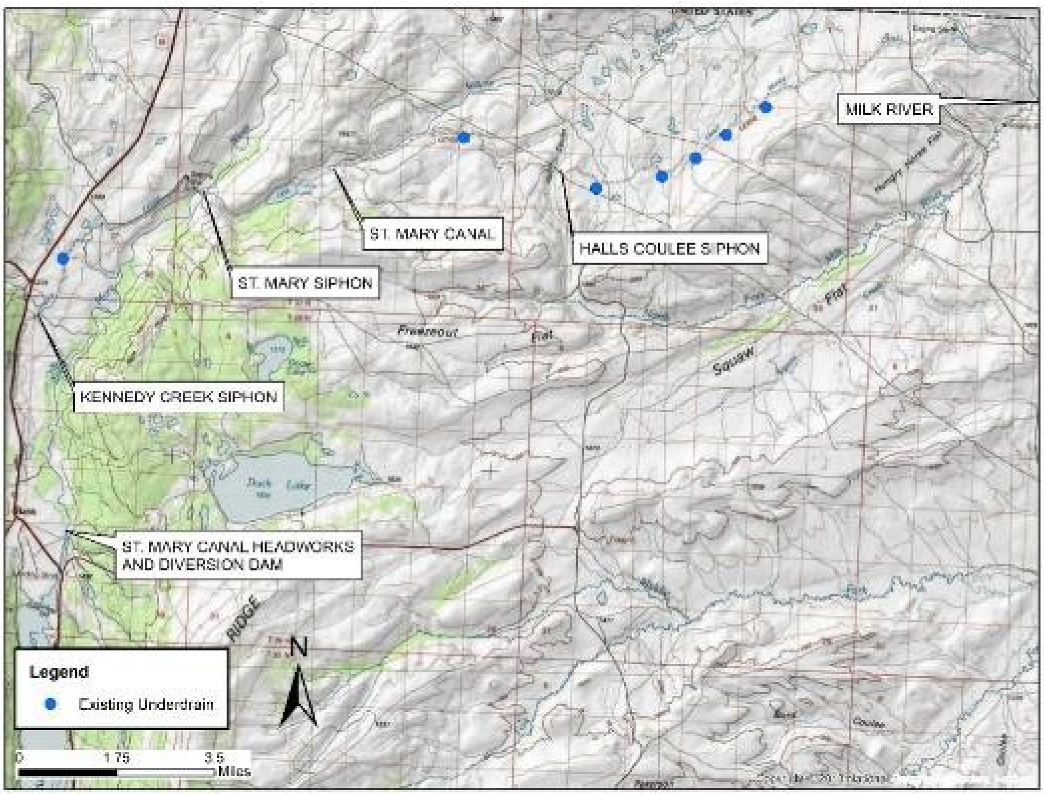
In addition to major natural drainages with designated underdrain structures, numerous smaller drainages contribute runoff towards the St. Mary Canal System along its extent at locations lacking any structures for the controlled conveyance of drainage and surface runoff either under the canal (underdrains) or into the canal (drain inlets). These smaller drainages were not delineated and are generally located between major underdrain structures. At said locations, runoff currently collects and ponds upstream of the St. Mary Canal System (i.e., the Canal acts as an earthen dam) and/or overflows uncontrolled into the St. Mary Canal System. The proposed design will allow for this water to drain through smaller culverts or traverse parallel to neighboring major drainages by neighboring ditches and flow paths.

Table D3-5. St. Mary Canal System Underdrains

Existing Station	Name	Existing Structure Description[1]	Existing Structure Length (ft)
330+69	Powell Creek Culvert	2 x 66" RCP	Unknown
794+46	Cow Creek Culvert	54" x 66" RCP	180
979+70	Culvert	30" RCP	143
1052+72	Culvert	30" RCP	140
1096+93	Culvert	30" RCP	168
1134+68	Culvert	30" RCP	143
1194+29	Culvert	30" RCP	157

[1] RCB signifies reinforced concrete box culvert and RCP signifies reinforced concrete pipe.

Figure D3-8. St. Mary Canal System Underdrains



Drop Structures

Prior to delivering water to the Milk River, the St. Mary Canal System achieves energy dissipation through dropping approximately 218 feet from the beginning of Drop Structure 1 to entering the Milk River. 204 feet of this drop in elevation is through a series of five drop structures. These five drop structures are shown in Figure D3-9 below. The length and vertical drop of each structure are detailed in Table D3-6.

Figure D3-9. St. Mary Canal Drop Structures

Table D3-6. Drop Structure Dimensions

Drop	Length (ft)	Vertical Drop (ft)
1	215	36.5
2	237	29.5
3	140	27.8
4	340	67
5	347	60.89

All five drop structures are reinforced concrete chutes with plunge pools/stilling basins at the bottom and are designed to convey 850 cfs. The drop structures were constructed between 1912 and 1915. Drop Structures 2 and 5 were replaced in 2020 after the catastrophic failure of Drop Structure 5 on May 17, 2020 (see Figure D3-10).

Figure D3-10. Drop 5 Failure on May 17, 2020[3]

According to the Geotechnical Engineering Report (Terracon, 2020), the Drop Structure 5 failure was likely caused by internal erosion of dispersive materials within the structure subgrade. The failure event was observed to have eroded the structure subgrade to maximum depths approximately 25 feet just downslope of the entry weir crest, and to widths as narrow as 10 feet but up to 20 feet in width. Subsequent observations of the structure site also indicate that the subgrade erosion likely precipitated tilting of the floor slabs within the drop structure. Then further erosion and piping ultimately caused the drop structure to become undermined, resulting in damage to the structure by tilting of the structure slabs and subsequent damage to the drop structure caused by water flow damage.

Over the years, repairs have been made to the drop structures including various concrete repairs ranging from the grouting of cracks to replacing entire sections of a structure due to extensive concrete deterioration and failure. More specifically, repairs include:

- Drop Structure 4 crest and chute replacement (2011)
- Drop Structure 3 chute floor replacement (2004/2005)
- Drop Structure 3 major rebuild of the plunge pool basin and wing walls (2008)
- Drop Structure 1 wing walls and stilling basin (2020)

Currently, Drop Structures 1, 3 and 4 show noticeable signs of chute sidewall and slab deterioration, wingwall settlement, exposed rebar throughout and cracking and spalling concrete

[3] Photo credit, Montana DNRC (Figure 8 - http://dnrc.mt.gov/divisions/water/management/docs/st-mary-rehabilitation-project/drop-structure-pictures.pdf)

evident along the chutes, chute sidewalls, wingwalls and plunge pool walls of each structure. See Figure D3-11, Figure D3-12, and Figure D3-13 below.

Figure D3-11. Drop 1 Chute Condition

Figure D3-12. Drop 3 Plunge Pool Headwall Condition

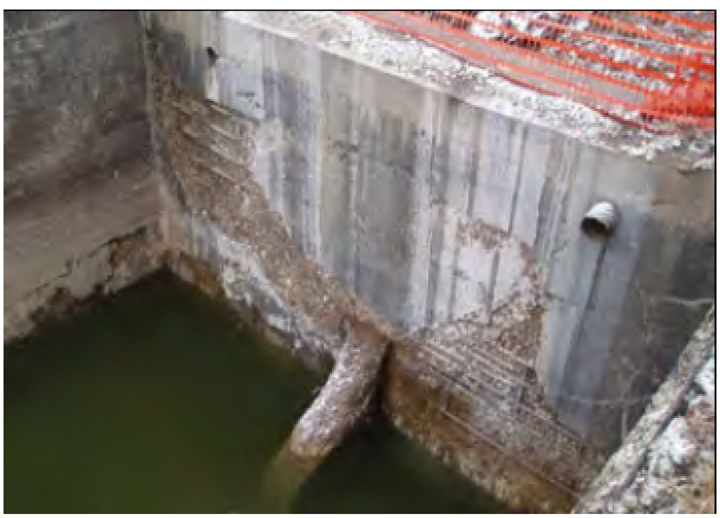


Figure D3-13. Drop 4 Chute Condition[4]

In 2014, Reclamation concluded that the Drop Structures were in poor condition and that they required significant repairs to bring them up to current standards and to improve reliability to acceptable levels (Darlinton, 2014).

In 2018 Reclamation released the report *2018 Associated Facility Review Examination Report St. Mary Diversion Dam and Canal Milk River Project, Montana*[5]. The purpose of the report in part was to perform an inspection of the St. Mary Canal System facilities to determine future maintenance needs and to gather design data for the possible replacement of the drop structures. Excerpts from that report are below for Drop Structures 1, 3 and 4.

Drop Structure 1:

The concrete floor of Drop Structure 1's stilling basin is in poor condition, with exposed rebar in various locations and in one location the damage has worn through the first mat of rebar and is beginning to degrade the second mat.

The terminal wall has significant concrete damage, with exposed rebar along most of the wall and holes that have extended into and past the second mat of rebar. It doesn't appear that the holes go all the way through to the backfill material, but it could happen in the near future and start to erode backfill material that is not only holding up the wall but also the chute.

There is mention of wingwall deterioration as well, however, the wingwalls were repaired in 2020.

[4] Photo credit: Bureau of Reclamation
[5] (U.S. Department of the Interior Bureau of Reclamation , 2018)

Drop Structure 3:

In 2008, the Drop Structure 3 terminal wall and both wingwalls (parallel to flow) were rehabilitated. Poor concrete persists on the far downstream wingwalls that are perpendicular to the flow. The wingwalls are falling into the canal and are only being held up by the rebar that is tied into the footer and other wingwalls.

Drop Structure 4:

The terminal wall has major cracking and spalling, and due to the nature of the cracking, is broken into separate blocks of concrete rather than one solid wall. The left wingwall has a large bulge and crack in the wall about 1/3 up from the bottom. It is assumed that the pressure being exerted on the wall from the fully saturated soils behind the wall and lack of weep holes in this section is causing the bulge and the wall is largely being held together by the rebar. Some repairs have been made to Drop Structure 4 including stabilization of the right wingwall and the filling in of a large hole downstream of the stilling basin that was approximately 50 deep wide, 70 feet long and 8-10 feet deep.

In Section 4.8.1, Reclamation (2018) concluded the following:

> *"In our opinion, the St. Mary River Siphon and hydraulic drops represent the greatest potential for catastrophic failure due to their present condition and estimated damage resulting from failure. Catastrophic failure of either of these two components would result in severe and irreversible environmental damage to the St. Mary River and the North Fork of the Milk River, respectively. Repairs would most likely take two years for significant failure of one of the two siphon locations and at least one year for a failed drop. This would create an economic disaster for north central Montana directly and indirectly for the remainder of the State."*

Severe deterioration within the existing plunge pools has occurred over time as a result of the impact of falling water, improper ventilation, cavitation and freeze-thaw damage. Protective measures should also be implemented to prolong the life of the concrete, specifically within the plunge pool, including a thicker concrete slab, ventilation, and air-entrained concrete which is more suitable for the harsh freezing conditions realized in this geographic region.

D3.4 Development of the St. Mary Canal System Modernization Alternatives

Modernizing the St. Mary Canal System included an evaluation of various measures that could be implemented to provide improved water delivery of the system. Factors that contributed to the analysis included:

- Restoring the St. Mary Canal System capacity to 850 cfs
- Conservation of water
- Improved operations and maintenance accessibility and efficiency

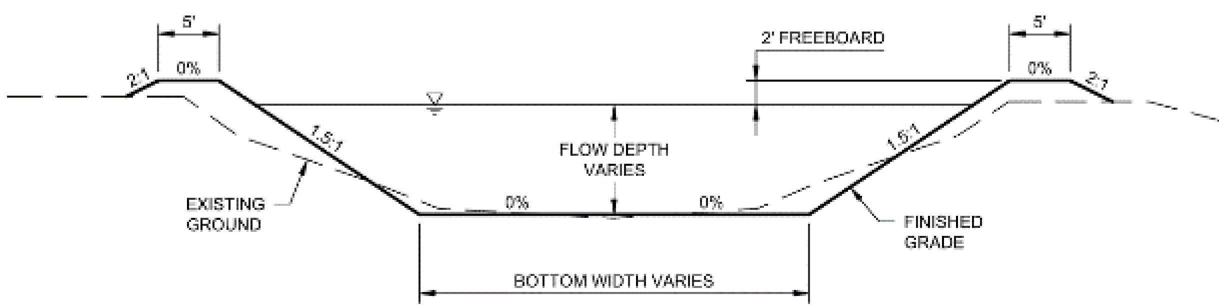
- Considerations of future operations and maintenance
- Resource protection
- Construction feasibility
- Capital cost

D3.4.1 St. Mary Canal System Delivery Measures

Open Channel Measures

Multiple open channel measures were considered to improve the conveyance of the St. Mary Canal System: 1) Improved earthen section and 2) Improved section with a geosynthetic liner. For each measure, a trapezoidal section with 1.5:1 (H:V) side slopes and 2' freeboard was considered per correspondence with Reclamation. A typical section of the canal is illustrated in Figure D3-14.

Figure D3-14. Channel Typical Section



Using the existing thalweg profile developed from survey, the focus of the open channel measures was set on the four reaches defined in Table D3-7.

Table D3-7. Diversion Structure Sections

	From	To
1	Diversion	Kennedy Siphon
2	Kennedy Siphon	St. Mary Siphon
3	St. Mary Siphon	Halls Coulee
4	Halls Coulee	Drop 1

The design dimensions of each reach were set to approximate the existing channel widths to limit the amount of cut/fill associated with constructions, while also targeting a minimum velocity that would assist in moving the sediment within the St. Mary Canal System. Due to the minimal slopes of the analyzed reaches, the design velocity was limited to 2.0 feet per second (fps). These velocities will move the suspended load but will be limited when trying to move the larger materials that are imported from neighboring areas of runoff and slides. The resultant design dimensions and velocity for each reach are listed in Table D3-8. Measure 1 represents an earthen channel with a Manning's value of 0.025 while Measure 2 represents a lined channel with a Manning's value of 0.016.

Table D3-8. Hydraulic Design Characteristics of the Open Channel Measures

Reach	Slope (ft/ft)	Measure	Material	Flow Depth (ft)	Bottom Width (ft)	Velocity (fps)	Cut (-) / Fill (+) (CY*)
1	0.000174	1	Earthen	8.5	26.5	2.5	31,716
		2	Liner	6.66	26.5	3.5	-31
2	0.000138	1	Earthen	8.8	28	2.3	143,779
		2	Liner	6.92	28	3.2	106,502
3	0.000105	1	Earthen	9	31.5	2.1	76,269
		2	Liner	7	31.5	2.9	172,163
4	0.000097	1	Earthen	9.17	32	2.0	72,015
		2	Liner	7.16	32	2.8	5,891

* = Cubic Yards

Table D3-9. Summary of the Cut/fill Totals for the Open Channel Measures

Measure	Cut (-) / Fill (+) (CY)
1	323,780
2	284,525

While Measure 2 requires less earthwork for construction due to the decreased design depth, it assumes an additional geosynthetic liner.

Pressurized Pipe Conveyance

Another measure to reduce the hydrologic losses through the St. Mary Canal System is a closed pipe conveyance system. This measure consists of piping the reaches of the canal between the existing siphon crossings. A closed pipe system is far less susceptible to the hydrologic losses and earthen instabilities that have been observed along the canal. For the proposed system to function at full capacity it was determined that a pressurized piping system be assessed. Using a pressurized conveyance system will reduce the likelihood of air entrainment within the pipes, further increasing performance of the system. The Environmental Protection Agency (EPA) computer program EPANET was used to assess the pressurized delivery system for the St. Mary Canal System. EPANET simulates the dynamic hydraulic behavior within pressurized-pipe systems. EPANET networks consist of pipe (links), pipe junctions (nodes), pumps, valves, and reservoirs. EPANET tracks the flow of water in each pipe and the resultant pressure at each node. The following assumptions were applied while developing the hydraulic model.

- The model was run at a design operating flow of 850 cfs.
- The model was run as a steady state simulation (one time step), the system was not evaluated over an extended period of time.

- The Hazen-Williams equation was used to quantify friction head losses.
- Minor losses were applied using a generalized loss per mile of reach.
- The proposed layout would approximately follow the same alignment as the existing Canal.
- Smooth steel pipes were the assumed material, as HDPE in a hydraulically comparable size was found to be significantly more expensive, to procure and transport to the site.
- Pressure flow through the siphons was not evaluated.

The hydraulic model for the pressure system consists of four reaches. The first reach begins at the St. Mary Diversion and terminates at the Kennedy Creek siphon inlet. The second reach begins at the Kennedy Creek siphon outlet and terminates at the St. Mary siphon inlet. Reach 3 begins at the St. Mary siphon outlet and terminates at the Halls Coulee siphon inlet. Reach 4 begins at the Halls Coulee siphon outlet and terminates at the Drop Structure 1 intake. Figure D3-15 shows the layout of the EPANET. Table D3-10 shows the physical parameters for each reach. A summary of the results at the pipe junctions is shown in Table D3-10. Based on the results it was determined that three 10-foot barrels will be required to convey the required design flows.

Figure D3-15. EPANET Model Layout

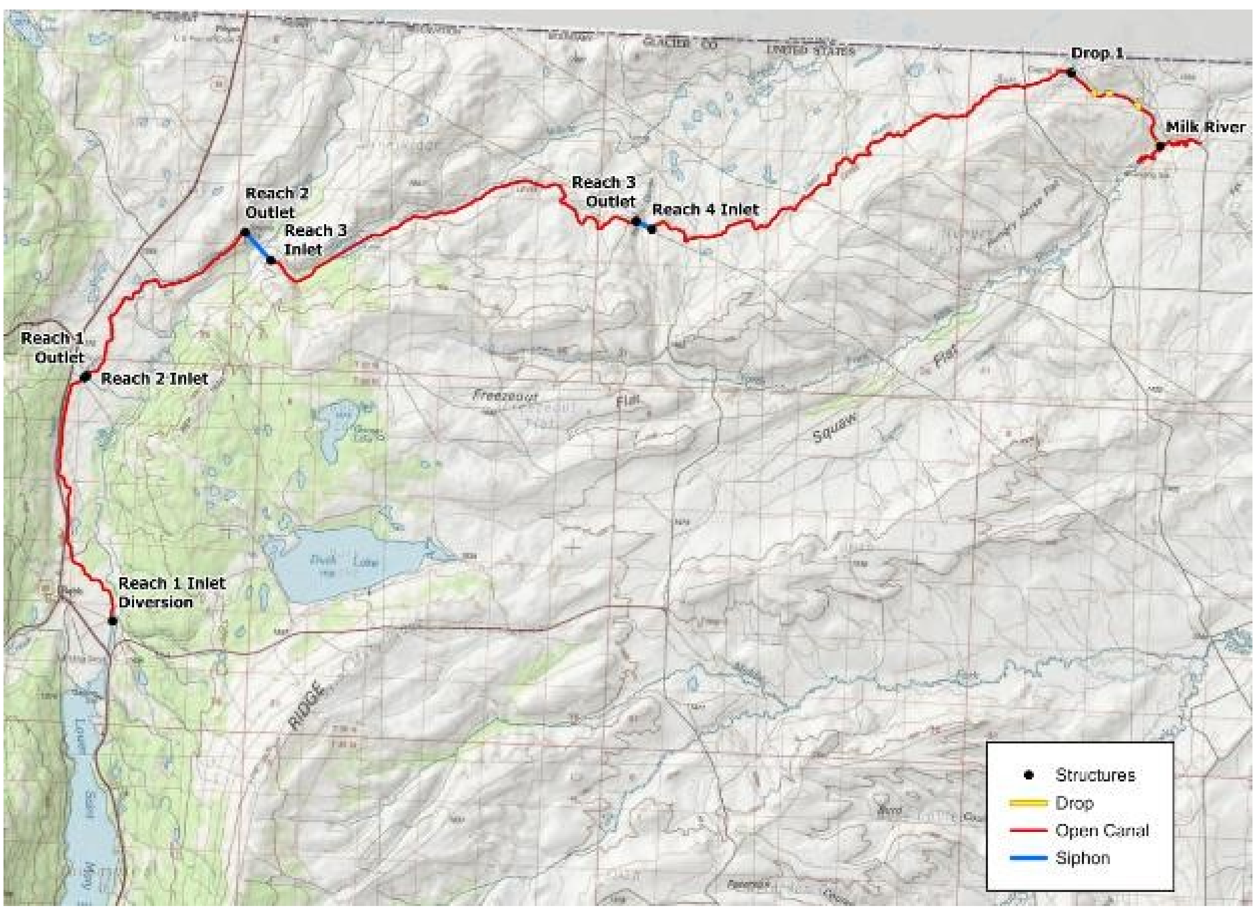


Table D3-10. Reach Modeling Parameters

Reach	Length (ft)	Diameter (ft)	Number of Barrels	Material	Roughness (C Value)	Minor Loss Coefficient
1	24,950	10	3	Smooth Steel	130	38.0
2	22,144	10	3	Smooth Steel	130	33.6
3	40,470	10	3	Smooth Steel	130	61.2
4	48,046	10	3	Smooth Steel	130	72.8

Table D3-11. Node Results

Node	Elevation (ft)	Total Head (ft)	Pressure (psi)
Reach 1 Inlet	4466.07	4482.30	7.03
Reach 1 Outlet	4446.93	4467.90	9.09
Reach 2 Inlet	4447.93	4467.90	8.65
Reach 2 Outlet	4444.93	4455.15	4.43
Reach 3 Inlet	4429.43	4455.15	11.14
Reach 3 Outlet	4423.43	4431.89	3.66
Reach 4 Inlet	4408.93	4431.89	9.95
Reach 4 Outlet	4403.93	4404.24	0.13

D3.4.2 Siphon Measures

Kennedy Creek Siphon Rehabilitation Measures

The existing condition of the Kennedy Creek Siphon warrants improvements to the crossing based on previous analysis conducted for the *St. Mary Canal, System Improvement Plan* (HDR 2022). The existing structure is deficient and results in excess backwater leading to ponding the design discharge in the canal; the condition also puts it at a risk of failure.

Based on the 2022 HDR Report, *Systems Improvement Plan*, one feasible measure for the Kennedy Creek Siphon improvements was analyzed:

- Measure 1: Constructing an additional 10-foot x 10-foot reinforced concrete box (RCB).

The new RCB would be constructed within the existing footprint of the canal crossing, running parallel to the existing culvert. For this measure, a phased construction approach would be used and would require Kennedy Creek to be temporarily diverted to one side of the crossing while half of the box culvert is placed. Following the placement of the first half of the box, the creek would be diverted to opposite side of the crossing to allow for construction of the remainder of the new box. Kennedy Creek would be reconstructed to its preconstruction location and dimensions following the completion of construction activities. Additionally, the existing siphon would be evaluated and rehabbed, which may include coating, slip lines, or patching.

D3.4.3 Drop Structure Measures

On May 17, 2020, Drop Structure 5 suffered a catastrophic failure (Figure D3-16). As a result of this failure, Drop Structure 5 was replaced in the summer and fall of 2020 along with the Drop Structure 2 structure. Each structure was replaced in kind with a concrete channel and stilling basin to convey flows and dissipate energy.

Prior to the Drop Structure 5 failure, HDR prepared a cost and fatal flaw analysis was done on Drop Structure 2 (HDR Engineering, Inc., 2020). This analysis considered several measures, each considering several variations, for replacement of Drop Structure 2 including:

- Measure 1: No-Action
- Measure 2: Reconstruct the Structure in Original Footprint
    - Measure 2a: Steel Insert
    - Measure 2b: Concrete Overlay
    - Measure 2c: Headwall and Pipes
    - Measure 2d: Reconstruct in Kind
- Measure 3: Measure Replacement Structure
    - Measure 3a East: Piped Conveyance on East Alignment
    - Measure 3a West: Piped Conveyance on West Alignment
    - Measure 3b East: Concrete Conveyance on East Alignment
    - Measure 3b West: Concrete Conveyance on West Alignment
- Measure 4: Canal Relocation

Figure D3-16. Drop Structure 5 Failure[6]

Shortly after the Drop Structure 5 failure, the MRJBOC, Reclamation and Montana DNRC conducted an engineering site inspection to assess the damage and determine whether an interim fix was feasible. The team concluded that the complexities and costs associated with an interim solution could not be justified, considering the anticipated costs and the minimal gains in water supply it would allow. Subsequently, the decision was made to immediately replace both Drop Structure 2 and Drop Structure 5.

Due to the age, existing condition, recent 2020 failure of Drop 5, and available literature reviewed for the drop structures, a replacement is recommended for Drop Structures 1, 3, and 4 with minor variations in cross section and overall layout to improve capacity, flow characteristics, and structure durability. The replacement Drop Structures' final design would likely be similar to the Drop Structure 2 and Drop Structure 5, which were constructed in 2020.

The cross section of the replacement chute would be rectangular, instead of trapezoidal, to better contain the flow and prevent overtopping of the sides. In addition, the sidewalls at the

[6] Photo credit, Montana DNRC (Figure 7 - http://dnrc.mt.gov/divisions/water/management/docs/st-mary-rehabilitation-project/drop-structure-pictures.pdf)

approach to the chute would be vertical, in place of the current, convoluted transition and warping sidewalls.

With the previous Drop Structure 2 fatal flaw analysis, success of the Drop Structure 2 and Drop Structure 5 replacements and for the purposes of this analysis, the remaining three Drop Structures (Drop Structure 1, Drop Structure 3, and Drop Structure 4) will be replaced.

D3.4.4 Operation and Maintenance (O&M) Road Measures

Existing O&M roads along the St. Mary Canal System are generally unmaintained dirt access roads with varying widths, typically 10-12 feet, which run adjacent to the St. Mary Canal System. The St. Mary Canal System is in a remote rural area and except for the first reach of the canal which generally parallels MT Hwy. 89, existing established highways and county roads which cross the St. Mary Canal System and allow access are extremely limited. As a result, access to much of the canal is limited to the existing O&M roads and requires traveling long distances along these roads.

Due to a lack of gravel surfacing, O&M roads generally do not provide all-weather access, with many sections impassable during adverse weather conditions and when wet. This significantly hinders the ability to perform O&M activities and access irrigation facilities, particularly during and immediately following storm events, which is often the most critical time to access irrigation facilities. This includes access to wasteway and drains which require manual operation to release excess water from the St. Mary Canal System. In addition, this poses a significant safety risk during use of the O&M roads, particularly when wet. Several sections also pose safety risks for access during dry conditions due to the narrow width of access roads for some reach as well as saturation and rutting/settling of the roadway subgrade.

For improved access along the St. Mary Canal System, O&M road improvements are recommended to provide all-weather access for the entire length of the St. Mary Canal System. Proposed O&M road improvements would establish 12-foot-wide all-weather access with 6 inches of compacted gravel surfacing. Subgrade preparation prior to gravel surfacing placement would include grading and compacting to establish a competent subgrade. The roadway subgrade and surface would be graded to provide a consistent cross slope of at least two percent for drainage off the roadway surface to prevent ponding. In addition, for select reaches of the St. Mary Canal System with very poor subgrade conditions, geotextile and/or geogrid placement over the road subgrade and prior to gravel placement may be considered for improved roadway subgrade stability and reduced rutting. O&M road improvements are recommended to facilitate the proposed rehabilitation of the overall system to better allow for construction access.

A desktop review of existing O&M roads along the St. Mary Canal System was completed which included reviewing areas along the canal lacking existing O&M road access. The total length of O&M roads along the St. Mary Canal System recommended for improvement to provide all-weather access to the entire Canal is 32.7 miles. Figure D3-17 below provides an overview map of the proposed O&M road improvements and Table D3-12 below provides a breakdown of the length of proposed O&M road improvements.

Figure D3-17. Proposed O&M Road Improvements

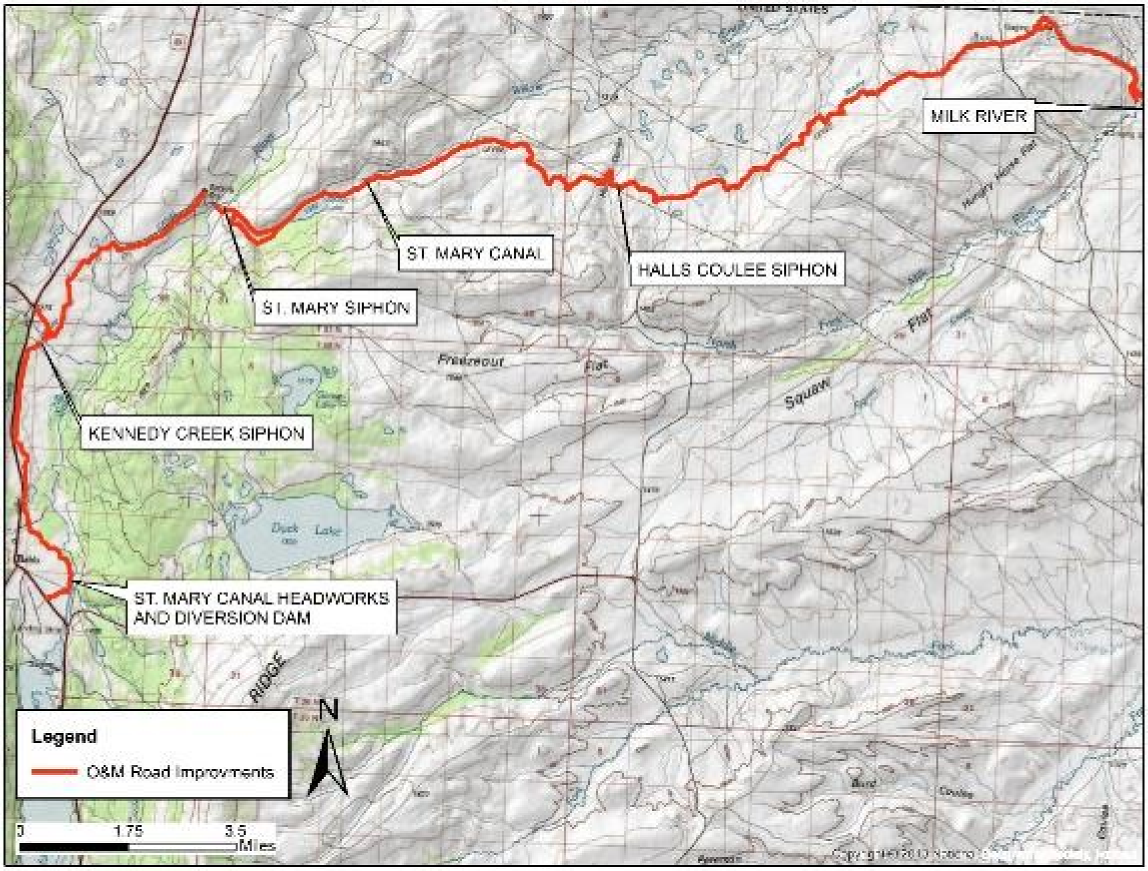


Table D3-12. O&M Road Improvements

Reach Description	Length of O&M Road Improvements (ft)
St. Mary Diversion to Kennedy Siphon	24,846
Kennedy Siphon to St. Mary Siphon	22,279
St. Mary Siphon to Halls Coulee Siphon	41,428
Halls Coulee Siphon to Emigrant Gap Road	46,471
Emigrant Gap Road to Drop 5	17,611
Drop 5 to Fox Ranch Road	4,610
Spider Lake Alternate Route	7,182
Kennedy Wasteway Access	2,984
Kennedy Siphon Access	1,140
St. Mary Diversion Access	2,283

Reach Description	Length of O&M Road Improvements (ft)
Drop 1 Access	1,191
TOTAL	**172,025**

The two measures evaluated for the O&M road improvements included the following:

1. O&M road improvements to establish an all-weather access road on one side of the St. Mary Canal System for its entire length.
2. O&M road improvements to establish an all-weather access road on both sides of the St. Mary Canal System for its entire length.

Both measures would include the same proposed roadway improvement section. An existing O&M road is present along one side of the St. Mary Canal System for much of its length. For Measure 2, however, additional subgrade preparation and grading will be required to establish an O&M road on the opposite side of the canal where one is not currently present. This additional effort is reflected in the cost estimate.

Regarding obtaining road surfacing gravel for O&M road improvements, multiple existing pits are present in proximity to the St. Mary Canal System, however, most are located along established highways and county roads. The development of additional gravel sources along the St. Mary Canal System should be evaluated to reduce the haul length. This will also facilitate a source for maintenance gravel for future road maintenance and may be needed for construction materials. Developing new gravel sources (mining) will require compliance with all federal, state, local, and tribal requirements.

In addition to initial O&M road improvements, a long-term O&M road maintenance plan is recommended which would include annual maintenance along the St. Mary Canal System in the form of grading and gravel placement. It is proposed that this includes a minimum length of O&M road maintenance each year.

D3.4.5 Monitoring, Instrumentation, and Control Measures

Today, the St. Mary Canal System and its major structures lack monitoring, instrumentation and control features. The ability to monitor and remotely control or operate certain canal system components can improve efficiency, monitoring and safeguards in the event of emergencies.

Due to the remote location of the St. Mary Canal, there are no United States cell phone carriers operating in the area. Along sections of the Canal there are Canadian cell phone providers with limited cellular access. Due to internal policies, Reclamation cannot use Canadian cellular service providers for monitoring and reporting Canal information. In addition, during the operating season when flows are greater than 500 cfs, Reclamation operations and maintenance crews drive the entire St. Mary Canal System on a daily basis. Radio communication can also be used for monitoring and instrumentation; however, radio repeater towers would likely need to be installed to allow for full coverage of the Canal system. These challenges combined with the fact that the St. Mary Canal System presently operates without any monitoring and instrumentation and Reclamation personnel monitor the Canal on a daily basis making monitoring, instrumentation and control a difficult proposition. Reclamation has also indicated that monitoring, instrumentation and control is not a priority or perceived as an operational benefit to the Canal system at this time (Reference St. Mary Canal System – Measures Analysis meeting notes dated August 25, 2022).

For the purposes of this measures analysis, monitoring, instrumentation and control was not analyzed further at this time.

D3.4.6 Wasteway Measures

The St. Mary Canal System includes two wasteways, both of which are in poor condition, and eight turnouts/drains with unknown capacities. All structures were designed with manual operation, although many are difficult to operate and/or inoperable. In their current condition, combined with their remote location and difficult access, the existing wasteways and turnouts generally do not serve as effective protective structures. Replacement of the existing structures with new structures designed for automatic spilling of excess discharges from the St. Mary Canal System would provide critical protection of the St. Mary Canal System infrastructure, improve system operation and maintenance, and allow for consistent conveyance of the design capacity while still reducing canal overtopping risk.

Included in the wasteway measures are the existing Kennedy Creek Wasteway, Halls Coulee Wasteway, and all existing turnouts/drains. This measure, however, does not address or include the Kennedy Creek Check Structure, which is contiguous to the Kennedy Creek Wasteway and is also recommended for replacement. The condition of all existing structures warrants replacement. In addition, many of the existing turnouts have slide gates located in the canal that generally are not accessible or difficult to access and operate when water is flowing in the canal.

The three measures recommended for wasteway measures are as follows, with additional details on all measures provided below:

1. Full Replacement of Wasteways and Drains
   - A. Replace the existing Kennedy Creek and Halls Coulee Wasteways in-kind.
   - B. Replace existing drains with new drains. The new drains would include concrete inlet structures with slide gates, pipes, and concrete outlet structures designed to function similar to the existing drains.
     - i. Measure drains designs which could include a vacuum siphon option, a pipe inlet and valve located at the downstream end of the pipe, etc., could be considered.
2. Improved Replacement of Wasteways and Turnouts
   - A. Replace the existing Kennedy Creek and Halls Coulee Wasteways with new improved structures. This would include evaluating different gate configurations for the new structures, automation, etc.
   - B. Replace existing drains with new side channel spillway structures.
3. Improved Replacement of Wasteways and Drains and Additional Structures

Measure 3 would be the same as Measure 2, except that additional side channel spillway structures would be added along the St. Mary Canal System at the locations identified in Figure D3-18 and Table D3-13. Under Measure 3, additional locations would provide additional operational control and protection (i.e., immediately upstream of the Halls Coulee Siphon Inlet where historical overtopping has occurred, upstream of the Kennedy Creek Siphon, existing grassed spillways, etc.) and locations without existing underdrain where surface drainage and runoff can enter uncontrolled into the St. Mary Canal System as discussed previously.

A summary of the three measures is presented below in Figure D3-18 through Figure D3-20, respectively, and they identify the new proposed side channel spillways corresponding with Measure 3, as well as the existing wasteways, turnouts (drains), and grassed spillways.

Measure 1 includes replacement of the existing turnouts. For this measure, although only 4 existing drains were identified from the Location Map prepared by Reclamation, 8 new turnouts were assumed based on *St. Mary Diversion Facilities Feasibility and Preliminary Engineering Report* (Montana Department of Natural Resources and Conservation, and Thomas, Dean & Hoskins, Inc., 2006) as described above.

Measures 2 and 3 include the construction of new side channel spillway (overflow spillway) structures. These structures are proposed for replacement of the existing turnouts (for Measure 2) as well as at new locations (for Measure 3). A standard design for all side channel spillway structures, modified as needed to match individual site constraints, is proposed. A conceptual side channel spillway structure standard design was developed in accordance with the *Design of Small Canal Structures*, (U.S. Department of the Interior, 1978) and is presented below.

Capacity of the existing drains is unknown, and therefore, a reasonable design capacity was established as the basis for the side channel spillway design. Runoff from major drainages along the St. Mary Canal System is managed by underdrain culverts (see below), however, many smaller drainage areas contribute uncontrolled surface drainage and runoff to the St. Mary Canal System at locations without underdrain culverts. The intent of the proposed side channel spillways is to provide protection for the St. Mary Canal System infrastructure downstream of locations where uncontrolled runoff enters the Canal (automatic spilling of excess discharges) and improved operational control. Based on the design discharges developed for underdrain culverts, the following preliminary design criteria were developed for conceptual side channel spillway design:

- Provide 50 cfs of capacity while maintaining 1 foot of freeboard (minor storms)
- Provide 100 cfs of capacity while maintaining 0.5 feet of freeboard (major storms)

The new proposed conceptual side channel spillway structure design would include a cast-in-place concrete structure with a 25-foot-long weir to allow for automatic spilling/overflow from the canal. The weir crest would be set just above the normal water surface elevation in the canal. Based on the existing canal typical prism (27-foot bottom, 1.5:1 side slopes, 10-foot canal depth, and 8-foot normal water depth) and assuming an overflow crest set 0.2 feet above the normal water surface, the proposed side channel spillway design would provide approximately 60 and 125 cfs of capacity while maintaining canal freeboard depths of 1.0 and 0.5 feet, respectively (based the canal design above), and 200 cfs of capacity at canal overtopping. In addition to the overflow crest, each side channel spillway would be equipped with a 54-inch slide gate to allow for draining of the canal. The side channel spillway structures would discharge to a 54-inch pipe which would convey flows to a standard Reclamation baffled outlet structure for energy dissipation. The conceptual design presented is one possible design option, and modifications for different design capacities and/or different designs could be considered.

Figure D3-18. Measure 1 Overview Map

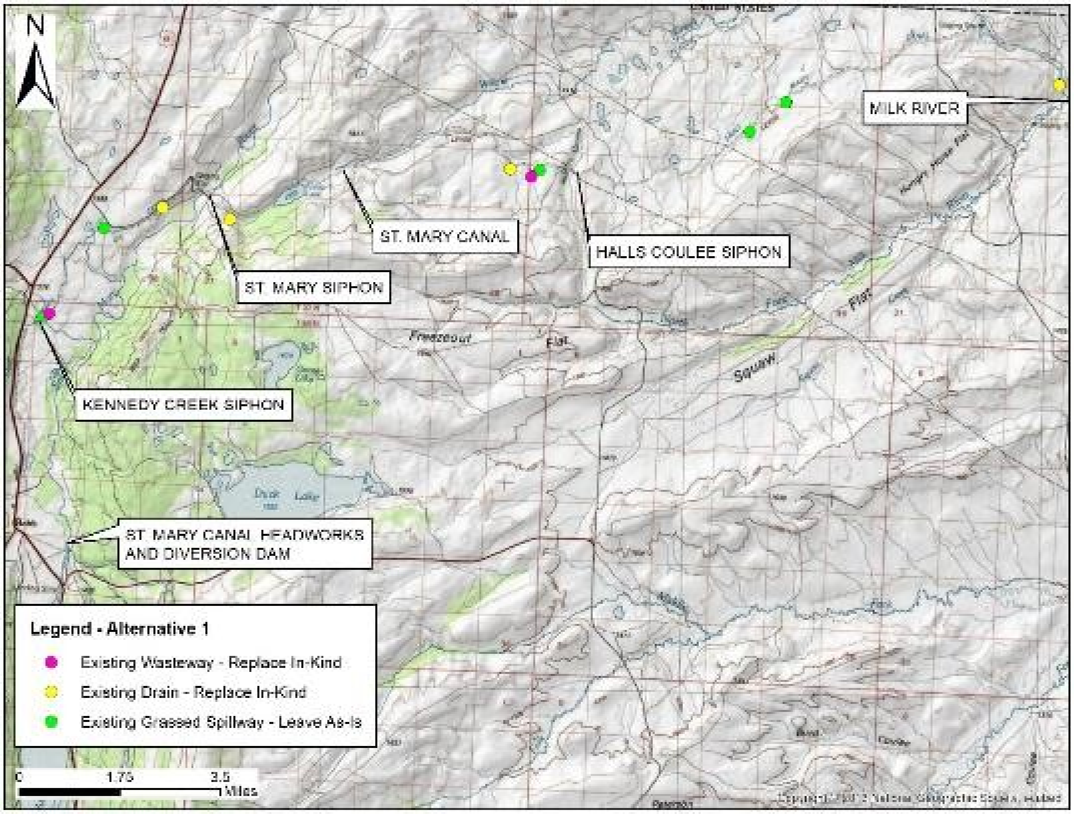


Figure D3-19. Measure 2 Overview Map

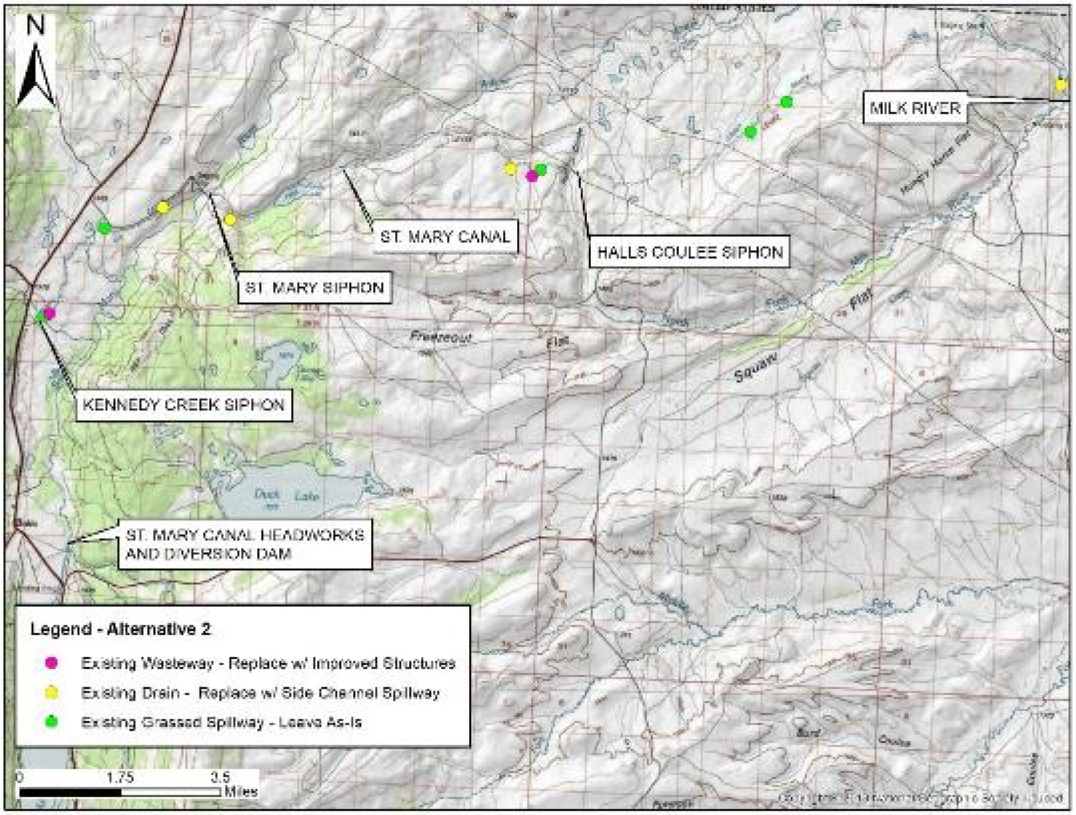


Figure D3-20. Measure 3 Overview Map

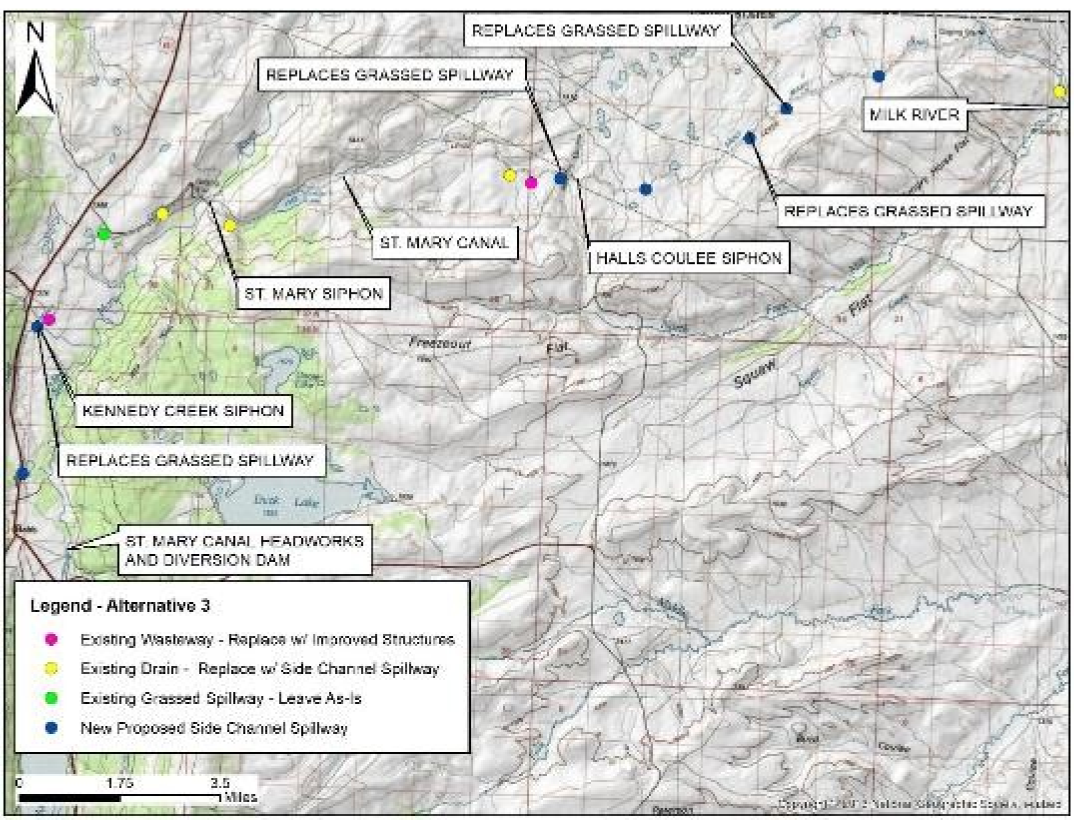


Table D3-13. Wasteways, Spillways, and Drains

Station	Existing	Measure 1	Measure 2	Measure 3
130+45	N/A	-	-	New Side Channel Spillway
269+91	Grassed Spillway	Leave as-is	Leave as-is	New Side Channel Spillway U/S of Kennedy Creek Siphon
277+20	Kennedy Creek Wasteway	Replace In-Kind	Replace w/ Improved Structure	Replace w/ Improved Structure
394+26	Grassed Spillway	Leave as-is	Leave as-is	Leave as-is
438+46	Turnout/Drain	Replace	Replace w/ Side Channel Spillway	Replace w/ Side Channel Spillway
532+53	Turnout/Drain	Replace	Replace w/ Side Channel Spillway	Replace w/ Side Channel Spillway
851+22	Turnout/Drain	Replace	Replace w/ Side Channel Spillway	Replace w/ Side Channel Spillway
884+93	Halls Coulee Wasteway	Replace In-Kind	Replace w/ Improved Structure	Replace w/ Improved Structure
901+78	Grassed Spillway	Leave as-is	Leave as-is	New Side Channel Spillway U/S of Halls Coulee Siphon Inlet
1039+45	N/A	-	-	New Side Channel Spillway
1145+71	Grassed Spillway	Leave as-is	Leave as-is	New Side Channel Spillway
1205+32	Grassed Spillway	Leave as-is	Leave as-is	New Side Channel Spillway
1296+10	N/A	-	-	New Side Channel Spillway
1529+50	Turnout/Drain	Replace	Replace w/ Side Channel Spillway	Replace w/ Side Channel Spillway
Unknown[1]	4 Turnouts/Drains	Replace	Replace	Replace

[1] Accounts for 4 additional turnouts/drains as identified in the *St. Mary Diversion Facilities Feasibility and Preliminary Engineering Report*

D3.4.7 Underdrains

Details on the existing underdrain culvert are provided in Table D3-14. The condition of existing underdrains is unknown, however, most underdrain culvert crossing have been in place since construction of the original St. Mary Canal System. In accordance with *Design of Small Canal Structures* (U.S. Department of the Interior, 1978), the recommended design storm event for underdrain culverts managing offsite surface drainage and runoff for irrigation canals is the 25-year storm event. Peak discharges contributing to underdrain culvert crossings were estimated using the StreamStats software developed by the U.S. Geological Survey (USGS) for estimating peak-flow frequencies at ungagged sites in Montana. StreamStats was utilized to delineate drainage basins and estimate peak discharges for different design events based on USGS Regression Equations. The St. Mary Canal System is located in the Northwest Region, and hence, USGS Regressions Equations for the Northwest Region were utilized within StreamStats to estimate peak discharges. Estimated peak discharges for the 25- and 100-year storm event are presented below in Table D3-14.

Table D3-14. St. Mary Canal Underdrains

Existing Station	Name	25-yr Discharge (cfs)	100-yr Discharge (cfs)	Measure 2	Measure 3	Length (ft)
330+69	Powell Creek Culvert	681	1,630	2 x 66" RCP	2 x 78" RCP	2 x 150
794+46	Cow Creek Culvert	363	921	54" x 66" RCB	72" x 72" RCB	180
979+70	Culvert	152	421	30" RCP	2 x 36" RCP	2 X 144
1052+72	Culvert	100	290	30" RCP	42" RCP	140
1096+93	Culvert	65	196	30" RCP	36" RCP	168
1134+68	Culvert	65	196	30" RCP	36" RCP	144
1194+29	Culvert	38	121	30" RCP	30" RCP	158

For development of the proposed underdrain culvert measures, two replacement measures were considered. One measure assumed replacement of all underdrain culverts in-kind (same size, material, and length as existing). Another measure assumed replacement with new underdrain culverts hydraulically designed and sized to manage the 25-year storm event based on the estimated peak discharges presented in Table D3-16.

The software HY-8 developed by the US Department of Transportation Federal Highway Administration was utilized for the conceptual design of underdrain culverts using estimate peak discharges from StreamStats. For designing underdrain culverts, the headwater criteria developed by the Montana Department of Transportation for mainline culvert crossings for the design event was utilized for as the basis for the conceptual hydraulic design. The headwater design criteria utilized is presented below in Table D3-15.

Table D3-15. Maximum Allowable Headwater Depth for the Design Event

Pipe Size	HW @ Design Flow[1]
≤ 42"	< 3.0*D or 3.0*R
48" – 108"	< 1.5*D or 1.5*R
≥ 120"	< D+2.0' or R+2.0'

[1] D signifies diameter of the pipe, R signifies rise of the pipe.

For developing conceptual proposed underdrain culvert crossing designs, the following assumptions were made:

- Culvert and downstream tailwater channel slopes were estimated as 1%.
- Culverts were sized to meet headwater design criteria presented in Table D3-16 for the 25-year storm.
- Flared and sloped end sections were assumed for reinforced concrete pipe culvert (RCP) and reinforced concrete box culvert (RCB) measures, respectively.

- Lengths of all proposed underdrain culverts were assumed to match existing (rounded up to the nearest two feet).
- One proposed measure was developed for each existing underdrain location.
- Replacement measures assumed the installation of three concrete seepage (percolation) collars along the length of the culverts and outlet riprap aprons.
- Replacement measures assumed traditional open cut installation.

The three measures recommended for underdrains culverts are as follows, with details on both replacement measures presented in Table D3-16.

1. No Action
2. Full Replacement of Underdrains
   A. This measure would replace all underdrain in-kind with the same size, material, and length as the existing underdrain culverts.
3. Improved Replacement of Underdrains
   A. The measure would replace all underdrains with new underdrain culverts sized to meet the headwater design criteria based on the estimated peak discharges.

Table D3-16. Underdrain Measures Summary

Station	Name	25-yr Discharge (cfs)	100-yr Discharge (cfs)	Measure 2	Measure 3	Length (ft)
330+69	Powell Creek Culvert	681	1,630	2 x 66” RCP	2 x 78” RCB	2 x 150
794+46	Cow Creek Culvert	363	921	54” x 66” RCB	72” x 72” RCB	180
979+70	Culvert	152	421	30” RCP	2 x 36” RCP	2 X 144
1052+72	Culvert	100	290	30” RCP	42” RCP	140
1096+93	Culvert	65	196	30” RCP	36” RCP	168
1134+68	Culvert	65	196	30” RCP	36” RCP	144
1194+29	Culvert	38	121	30” RCP	30” RCP	158

For Measure 3, the Powell Creek Culvert may be a good candidate for replacement with a RBC. The proposed measure presented in Table D3-16 is comprised of 2 – 78-inch RCPs, however, a 12’ x 6’ RCB would also meet the design criteria and would have a similar cost to the double barrel RCP measure.

All conceptual underdrain culvert designs presented in Measure 3 provide larger flow areas/increased capacity versus the existing underdrain culvert crossings except for Station 1194+29. All proposed conceptual underdrain culvert designs presented in Measure 3 were also checked for the 100-year storm event. The 100-year storm event exceeds the capacity of all and would result in overtopping into the St. Mary Canal System. Providing capacity to manage the 100-year storm event without overtopping into the St. Mary Canal System would require considerably larger culverts for most locations. The conceptual designs presented in Measure 3 generally provide increased capacity versus the existing culverts. Hence, further increasing the size of culverts was not considered for this Measure at this time but could be in the future. Additional coordination with maintenance personnel is recommended to provide additional input into the performance of existing underdrain culverts along the St. Mary Canal System.

D3.4.8 Slope Stability Measures

Background

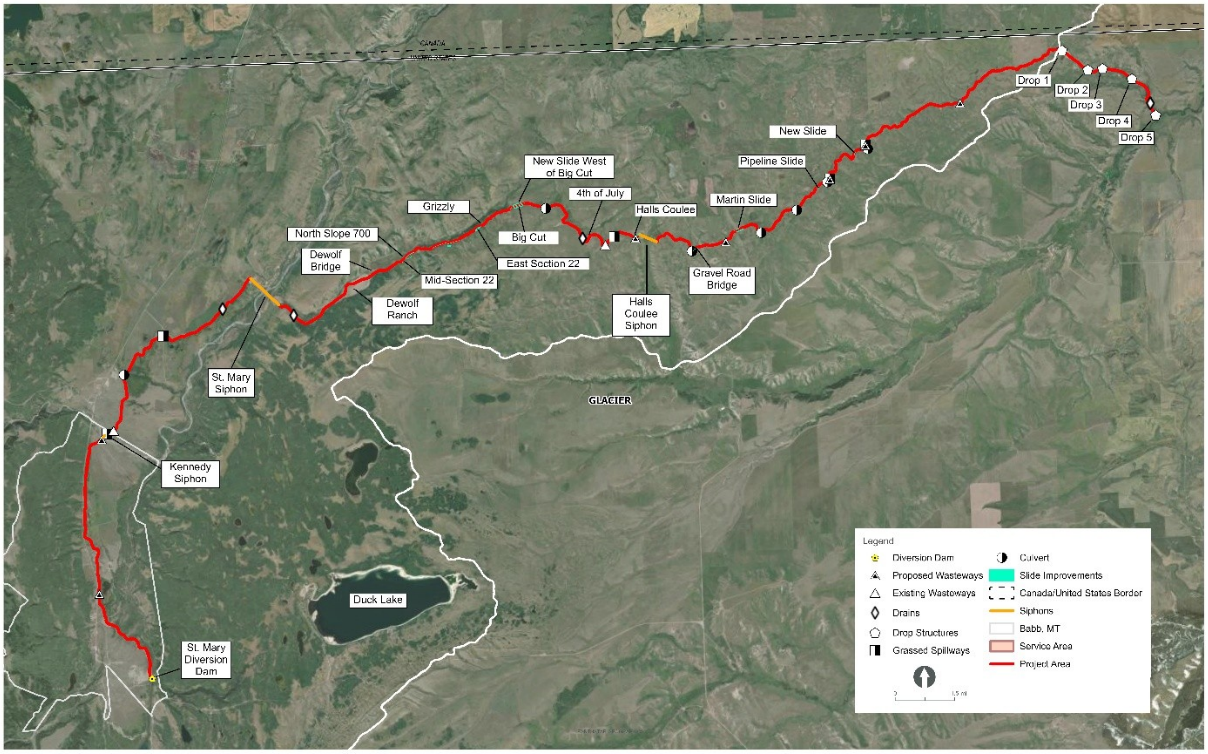
Slope failures are common along the St. Mary Canal System and throughout the areas near the canal due to poorly consolidated glacial sediment, over-steepened slopes and banks, and fluctuations in groundwater conditions due to St. Mary Canal System operations and precipitation. Landslides adversely affect both the reliability (potentially causing overtopping and failure of Canal banks) and the St. Mary Canal System capacity by reducing the cross-sectional area available for canal flows. Many of the assessments of landslides reference instances or seasons of heavier than usual precipitation and are evidence that consideration of methods of either limiting the amount of water that infiltrates into the soils in a slide area or dewatering the soils in a slide area is important to achieve an effective treatment of the slides.

Reclamation has a long history of addressing areas along the St. Mary Canal System where movement of the soils in the slopes adjacent to the canal is impacting the canal to some significant extent. Slope movement adjacent to the St. Mary Canal System has often been addressed by removing the material within the canal prism at the toe of the slides and reshaping the banks. Excavated material was either hauled off or placed on top of the slide area, depending on available access. More recent slides were repaired by flattening the slopes and rebuilding the banks.

Identified Landslides

The following is a summary of the slides that have impacted the St. Mary Canal System using excerpts from Reclamation reports. Locations are shown on Figure D3-21. Some have not been active for a number of years and are only being visually monitored. Others remain active and are included in the decisions about where to spend limited funding for maintenance. Regardless of their current status, they have been included here for three reasons: 1) Modernization of the canal will likely involve excavation/reshaping of the canal prism in or near these slide areas and could cause the slide to move again unless the instability is addressed, and 2) Excavations for modernization of the canal could cause areas that have been stable to become unstable whether they have been previously identified as a slide area or not, and 3) Specific future high precipitation events could cause new instabilities to appear if the potential is not considered during design phases of the project.

Figure D3-21. Landslide Location Map



St. Mary River Siphon:

The St. Mary River Siphon slide is located near Camp Nine and transports water across the St. Mary River. Shallow soils in the slopes on both sides of the valley have moved downhill toward the river resulting in damage to the siphon pipes. Remediation work has been done on the siphon pipes (Lasater, 2020). With the proposed changes to the canal prism, the potential for future instability will be addressed as part of the replacement of the existing siphons.

Recent Update:

Remediation work on the St. Mary River Siphon slide was completed during the summer of 2025 when the St. Mary Siphon was replaced following a catastrophic failure.

DeWolfe Ranch:

The DeWolfe Ranch slide is located approximately 0.6-mile down canal from the east end of Spider Lake. This rotational slide is situated in glacial till. The slide is about 1,200 feet long at its base and approximately 5.55 acres in area. The slope failed rapidly in 1995, triggered by heavy precipitation.

DeWolfe Bridge:

This slide is located on the south hillside about 1.1 miles down canal from Spider Lake This rotational slide is situated in glacial till and is approximately 1,000 feet long at its base and approximately 5.80 acres in area. Reclamation continues to monitor this slide for movement.

Mid-Section 22:

This slide is located about 1.6 miles down canal from Spider Lake on a brushy section of the south valley wall in glacial till. The slide is about 500 feet long and approximately 4.60 acres in area. The slide first appeared after a period of heavy precipitation triggered movement. Remedial work performed in 2003 included material removal and grading.

North Slope 700:

The North Slope 700 slide is located near station 700+00 and occurred on the left side of the canal O&M road. This fill slope area was improved by excavation into the right canal cut-slope – moving the canal prism to the southeast. This accomplished three primary objectives: a straighter canal corridor through this section; a wider access road; and an increased seepage pathway through the canal fill-slope. This slide totals approximately 1.91 acres. No significant changes were noted during the last inspections.

East Section 22:

The East Section 22 slide is just east of the Mid-Section 22 slide, approximately 1.7 miles down Canal from Spider Lake and is an old rotational slide in glacial till about 300 feet long and approximately 10.11 acres in size. Movement since 1996 has been along the extreme eastern end of the old slide in an area of about 75 feet long by 40 feet high. The slide reactivated in 1998, and then to a minor extent in 2002. Movement is associated with heavy rainfall events. The scarp at this slide is visible, however vegetation is increasing in and around it. Reclamation is continuing to monitor this site.

Grizzly:

The Grizzly slide is located near station 735+00 on the left side of the canal. Slope failure occurred along the left canal bank and into the canal. The scarp was approximately 1 foot high and encroached about 3 feet into the canal O&M road. The slide failed after a period of high precipitation and was of small volume (about 75 cubic yards) and estimated at about 15 feet across by 35 feet long. The slide is approximately 2.40 acrs in area.

New Slide West of Big Cut:

Waste material from the remediation of the Big Cut slide was deposited off of the north bank of the canal, immediately west of Big Cut. The added weight combined with a seep through the canal likely contributed to the slide. The head scarp moves toward the canal every year and is a likely area for a blowout if sliding continues. This slide area will likely need to be reshaped/resloped and seepage through the canal in these areas should be addressed. The slide is approximately 1.39 acrs in area.

Big Cut:

The Big Cut slide is a series of interconnected rotational slides that persist up to 2,500 feet through a deeply cut section of the Canal. The slide is about 2.8 miles down canal from Spider Lake and is approximately 6.88 acres in size. A large excavation program in 1996 removed material from the canal prism and reshaped the side slopes. Mitigation work was completed between 2011 and 2017. Reclamation continues to monitor this area.

4th of July:

The 4th of July slide is located at approximate station 860+00 on a sharp bend of the canal in a cut-and-fill section about 4.7 miles down canal from Spider Lake just upstream from the Halls Coulee wasteway structure. The fill section of the canal failed in 1995. The canal alignment was excavated further south into native material which reduced concern of failure. The south bank was rebuilt and remains in good condition. The north slope, downhill of the canal, was reshaped and drainage was added. The slide is approximately 4.36 acres in size.

Halls Coulee:

The Halls Coulee slide is located at approximate stations 910+00 and 935+00 . Most of the slumping occurred well upstream of the siphon after a period of heavy rainfall. This slide complex is located along the excavated hillside in Quaternary glacial till which mantles the Cretaceous Horsethief Sandstone found at the siphon inlet. The slope has been reshaped.

Recent Update

During replacement of the Halls Coulee Siphon, work to remediate the Halls Coulee Slide will be completed. Work on the siphon is ongoing during the time of this report.

Gravel Road Bridge:

The Gravel Road Bridge slide is located near station 980+00 about 6.2 miles down Canal from Spider Lake on the left side of the Canal and access roadway. The slide occurred into the adjacent ravine. Since mitigation, this slide has not shown any signs of movement, but a seep has been observed near the base of the slope. Reclamation continues to monitor this slide area which is approximately 0.64 acre in size.

Martin Slide:

The Martin Slide is located near Station 1030+00 in a deep cut area of the canal, approximately 8.1 miles down canal of Spider Lake. The slide failed several times, most extensively in 2002 after a period of high precipitation. The slope was remediated prior to the 2007 inspection. Since 2007, there has been no change. Reclamation continues to monitor this slide which is approximately 2.28 acres in size.

Pipeline Slide:

The Pipeline slide is located near station 1125+00 on the south side of the Canal about 9.9 miles down canal from Spider Lake. The slide area has been reshaped but exhibits slow creep into the canal. Reclamation is continuing to monitor this area which is approximately 0.68 acre in size.

New Slide:

The New Slide is located near station 11850+00 on the south side of the Canal approximately 6.6 miles from the convergence of the canal with the North Fork River. This slide has an area of approximately 0.43 acre.

Recommended Actions

Over the years, Reclamation employees have repaired the slide areas numerous times. Slides have generally been repaired by excavating the slide material within the canal prism and placing it on top of the slide area or disposing of the material up and downstream of the slide. These efforts have had some success.

There are three main elements in repairing landslides: 1) removing the load from the top of the slide, 2) adding weight to the base of the slide, and 3) increasing the strength of the soil. Removal of material located at the top of the slide removes some of the weight that drives the slide. Installing additional material at the base of the slope often required relocating the Canal. Improvement of soil strength is primarily accomplished by reducing the amount of water held in the soils within the slide area – which reduces the weight driving the landslide and pore pressure. Typical landslide repair section views are shown in Figure D3-22. Repair methods for landslides typically use one or more of the three elements. Geologic investigations are critical in determining which method of repair will work best for a particular location.

Long-term solutions for the slide areas should include consideration of the following:

- Geologic investigations need to be conducted prior to finalizing any repair method. Gradations for filter materials need to be based on particle sizes of the native materials.
- Moving the centerline of the canal away from the slide would allow the installation of additional weight at the toe of the slides (gravel/riprap).
- Removing as much of the weight off the top of the landslides as possible by flattening the exposed slopes. However, only a limited amount of material can be removed due to the topography of the area and the limited amount of easement width.
- Excavated material needs to be removed, placed, and compacted on the downhill side of the canal.
- Control of subsurface and surface water should be included in the form of filter drains or surface swales to direct as much water as possible away from the unstable soils.
- Placement of gravel/riprap on both banks of the canal. This will reduce erosion, add weight to the base of the slides, and provide for a filter for seepage entering the Canal.
- All disturbed areas need to be re-seeded to prevent erosion and reduce water absorption into the soils.

Figure D3-22. Typical Sections

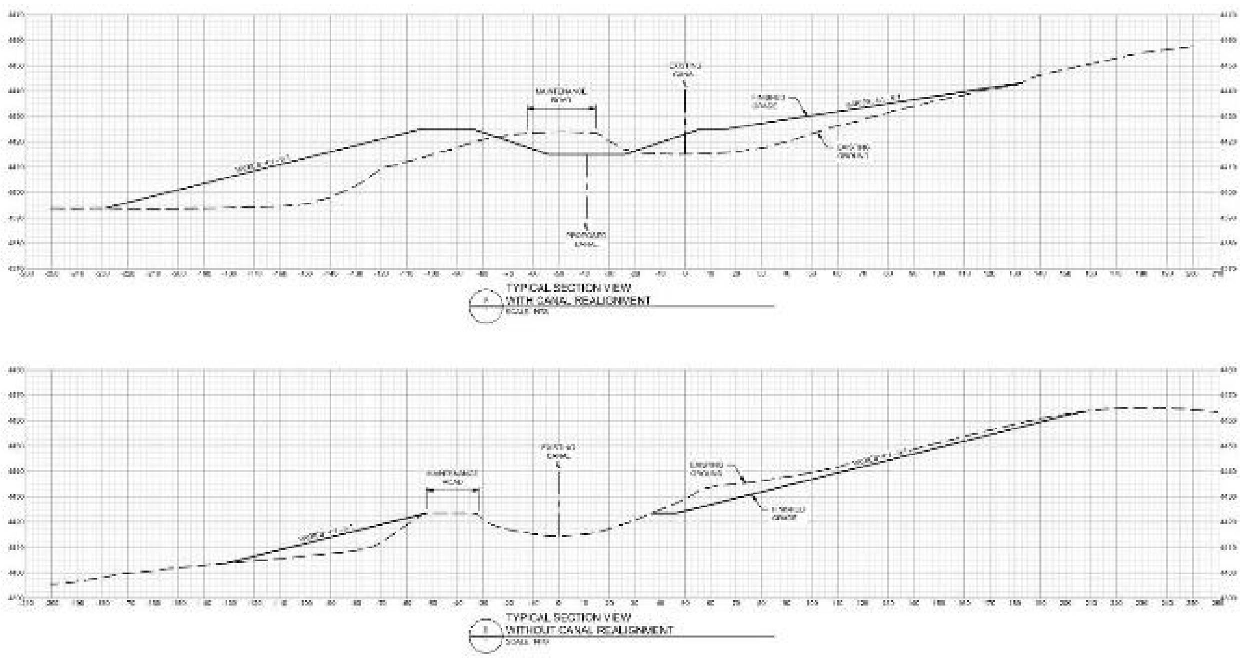
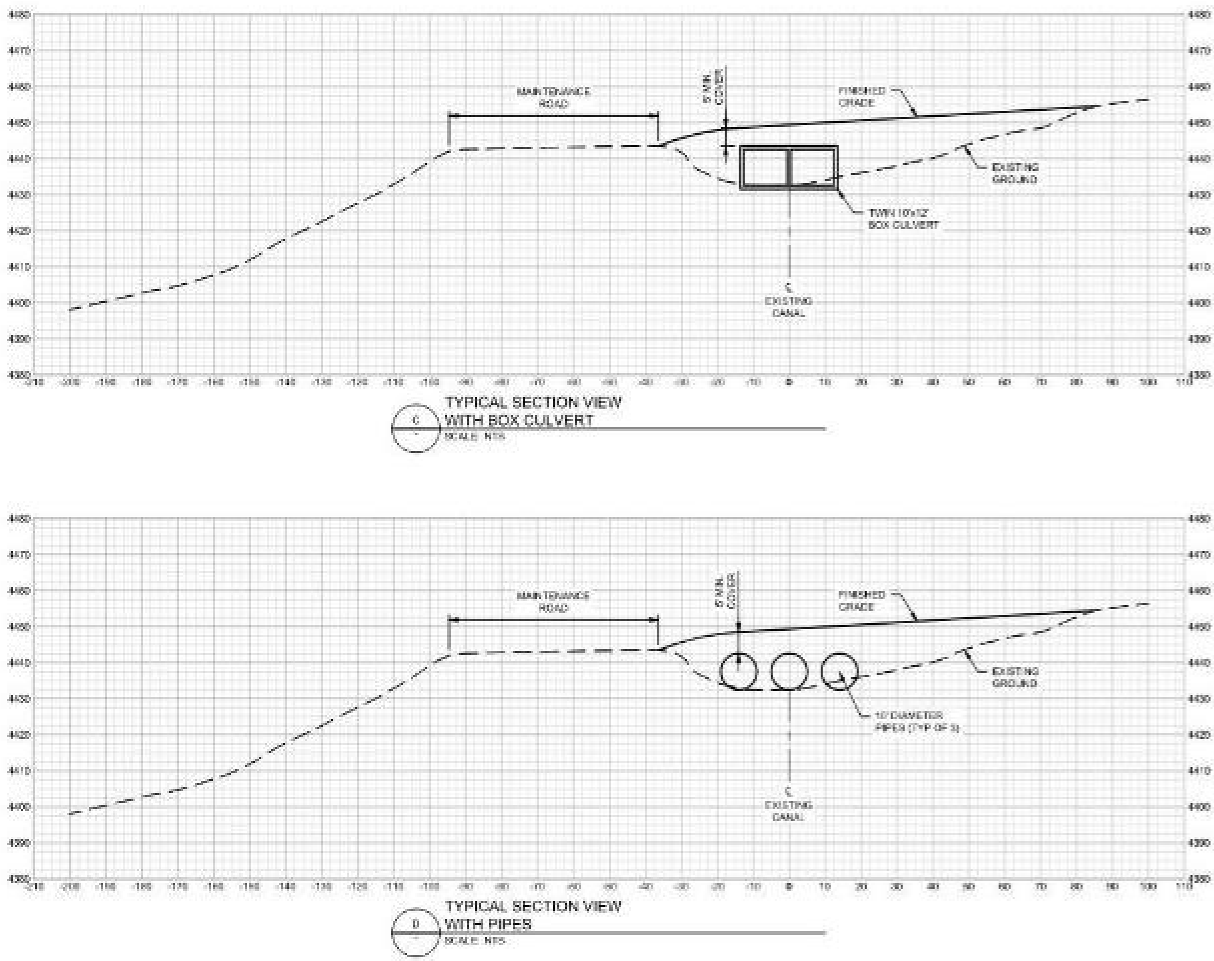


Figure D3-23. Landslide Areas Typical Piping Measures



Options using box culverts or piping to carry the flow were also considered and are shown in Figure D3-23. HDR evaluated these options using the pressurized piping hydraulic analysis that was completed as described in Section 4.3.2. It was assumed that the same size and number of pipes would be adequate for carrying 850 cfs past the slide areas. Therefore, two piping measures have been included that use three 10 ft diameter pipes with concrete entrance and exit structures. The pipe would be placed in the existing Canal at the location of the slide and then backfilled to provide approximately 4 to 6 feet of cover. This would place more soil and weight on the toe of the slide as well as reducing at least some of the slope of the slide. To provide a more complete cost analysis, both concrete and steel pipe were considered.

Another measure was included that would perform essentially the same as the piping measures but would use a twin box culvert. Each of the box culvert openings would be 10’ high by 12’ wide. Concrete entrance and exit structures would be included and the backfill of the box culvert would be done to provide 4 to 6 feet of cover over the box culvert and provide the same benefits for slope stability that the backfill of the piping would provide.

Other areas and locations have been mentioned in the past has having slide activities. Some had no impact on the Canal and were dismissed. Others were minor in nature and were “repaired” with a minimal level of effort. This should not be interpreted to mean that a year of higher precipitation would not result in movement of currently stable slides or the development of slides in areas where none had been previously identified.

The scope of this study is limited to known slides that are or have the potential to impact the Canal. For those slides noted above, the estimated extend of the slide was used in conjunction with available topography to estimate quantities of excavation and length of drainage features. Some geotechnical information has been gathered by Reclamation in the past for some of the slide areas, but these areas have been the subject of past maintenance efforts – making the available information inadequate for conceptual design. At the time design is pursued for remediation of each of these areas, specific geotechnical investigations should be performed and the data pertaining the subsurface materials should be used to guide design decisions and limit the measure treatments to just those that would effectively address the known slope instabilities. For the SIP the estimated level of effort was limited to:

- Excavation of materials in the slide to lay back the slopes within the available Canal easement as much as possible.
- Placement and compaction of that material on the downhill side of the Canal.
- Installation of a single swale or drainage trench across the top of the slide area to collect water and redirect that water to a location outside of the swale.
- Placement of riprap across the toe of the laid-back slope; and
- Re-seeding of the disturbed area.

D3.4.9 Animal Intrusion Measures

Livestock and wildlife can damage canal embankment slopes and/or geosynthetic lining systems by grazing, trampling, and rooting. Livestock also enter the canal prism to water. Hoofed animals can form depressions that lead to erosion gullies which enlarge over time. Numerous locations along the St. Mary Canal System indicate bank erosion and impacts to the Canal from livestock and wildlife.

Several options exist to mitigate domestic animal and wildlife intrusion into the canal prism including fencing and working with wildlife agencies to identify measures to deter wildlife use of the canal.

One option for mitigating livestock intrusion is to limit and control access to the canal. Areas where livestock historically access the canal can be fenced off. Selected access points should have gates and be fenced off to control the area that livestock can access.

A common and often preferred mitigation option is to provide livestock and wildlife water via a turnout with a small pond or watering tank combined with fencing to disincentivize livestock and wildlife access to the canal. This method is preferred because it will not allow animals direct access to the canal, preventing embankment damage, erosion and potential water quality issues.

D3.4.10 Hydropower Measures

Hydropower measures were assessed through the five Drop Structures at the end of the St Mary Canal System. The Blackfeet Tribe has first rights to any hydropower generated from the improvements within the St. Mary Canal System. Two previous studies were completed on the hydropower feasibility. TD&H prepared a study in 2006 (Montana Department of Natural Resources and Conservation, and Thomas, Dean & Hoskins, Inc., 2006) and HKM Engineering prepared a study in 2007 (HKM Engineering, 2007). The TD&H and HKM studies analyzed historical discharges through the St. Mary Canal System to estimate water supply used for the power generation calculations. It was determined that two flow conditions be used, the operating flow of 700 cfs and the maximum design flow 850 cfs.

These previous estimates of average annual power production may have assumed that the Canal will operate for 12 months per year instead of 6 months (occurring late April through early October). Due to typical winter weather – 6 months are more likely and would reflect a more realistic window Canal operation and corresponding Canal production.

The TD&H study consists of relocating 9,500 feet of the St. Mary Canal and bypassing Drop Structures 1 through 4 and replacing with a single drop structure with three penstocks through the realigned Canal. The TD&H hydropower measure with 160 feet of head, and maximum flow ranging from 228.7 cfs to 277.7 cfs, per penstock, would require three Francis or Kaplan turbines (Table D3-17).

Table D3-17. TD&H Hydropower Study Summary

Flow Scenario	Average Monthly Generation (kWh)	Average Annual Generation (MWh)
700 cfs	1,630,869	19,570
850 cfs	1,684,831	20,218

The HKM study analyzed two scenarios that were found to provide greater benefits than the scenarios evaluated in the TD&H study. The first scenario had three separate sections of the drop structures being replaced with penstocks, Drop 1 to Drop 3, Drop 4, and Drop 5. Like the TD&H study, HKM analyzed two flow scenarios through the hydropower measures, 700 cfs and 850 cfs (Table D3-18).

Table D3-18. HKM Hydropower Study Summary – Measure 1

Flow Scenario	Drop	Head (ft)	Maximum Flow (cfs)	Turbines Needed (Francis or Kaplan)	Average Monthly Generation (kWh)	Average Annual Generation (MWh)	Total Annual Generation (MWh)
700 cfs	1-3	90	228.7	3	917,364	11,008	26,053
	4	66	228.7	3	672,734	8,073	
	5	57	228.7	3	580,997	6,972	
850 cfs	1-3	90	277.7	3	947,717	11,373	26,916
	4	66	277.7	3	694,993	8,340	
	5	57	277.7	3	600,221	7,203	

The HKM study also looked at a second measure that constructed a new Canal that bypassed Drops 1 through 4 and then used penstocks to carry the flows to a single power plant near the bottom of Drop 5 (Table D3-19).

Table D3-19. HKM Hydropower Study Summary – Measure 2

Flow Scenario	Drop	Average Monthly Generation (kWh)	Total Annual Generation (MWh)
700 cfs	1-5	2,171,095	26,053
850 cfs	1-5	2,242,931	26,916

The HKM report presented Figure D3-24 and Figure D3-25 that represents the two measures.

Figure D3-24. HKM Proposed Configuration–Three Penstocks (Drops 1-3, Drop 4, and Drop 5)[7]

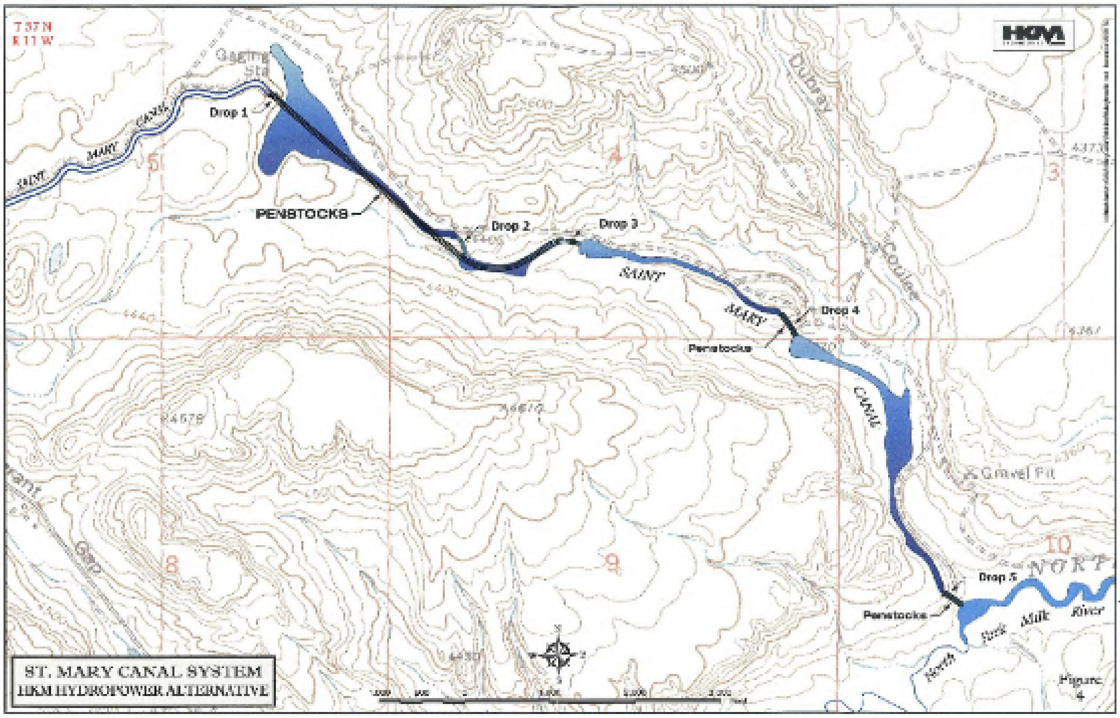
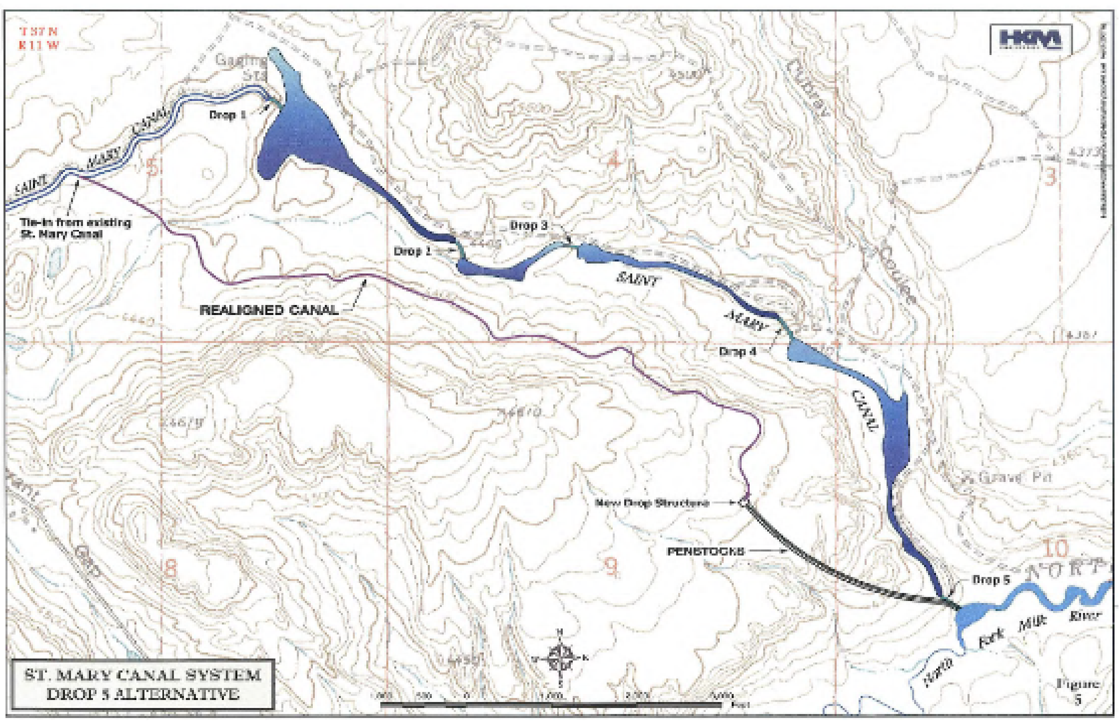


Figure D3-25. HKM Proposed Configuration – Realigned Canal and Drop 5 Penstocks[8]



[7] (HKM Engineering, 2007)
[8] (HKM Engineering, 2007)

The HKM study assessed the economic feasibility of the measures. It was determined that annual net losses occur with every measure, as such hydropower from the cost and rate of return basis is not favorable. Table D3-20 shows the original calculations for the two HKM measures for the 850 cfs options as presented in the HKM report.

Table D3-20. Original Hydropower Cost Assessment[9]

Hydropower Measure	Hydropower Field Costs	Unlisted Items (10%)	Contingency (20%)	Engineering (20%)	Total	Annual O&M Costs
HKM Drops 1-5 at 850 cfs Canal Capacity (Original Calculation)	$22,083,750	$2,208,375	$4,858,425	$5,830,110	$34,980,660	$524,710
HKM Drop 5 at 850 cfs Canal Capacity (Original Calculation)	$25,568,400	$2,556,840	$5,625,048	$6,750,058	$40,500,346	$607,505

The HKM analysis incorporates several assumptions that HDR has addressed in this analysis. First, HKM assumed the Canal would operate year-round as opposed to the 6 months of Canal operation that the Canal is limited to now. Second, HKM did not address the fact that power produced on the Blackfeet Reservation is owned by the Blackfeet Tribe. The HKM study assumed that the power could be carried on transmission lines to a location near the Del Bonita Border Crossing into Canada and then sold into the grid off the reservation. The Blackfeet Tribe has not indicated any preference for what they want to do with the power that could be produced by hydropower development at the St Mary Canal drop structures. HDR has addressed these issues by:

1. Assuming that power will be carried on transmission lines to Browning for tribal use. In addition, it is known that obtaining right of way for a power line can be extremely complex due to land ownership arrangements on the Reservation. Therefore, the transmission route was altered to follow either the Canal or existing public roadways between the drop structures and Browning. The route begins by following the Canal maintenance road west to Galbreath Road, then south to Duck Lake Road before continuing south to Browning on Duck Lake Road for a total of 38 miles.
2. The analysis of power production will be limited to 6 months in compliance with the existing time frame for Canal operation.

For the purpose of this SIP, HDR reassessed the cost of the hydropower measures with updated parameters. The cost calculations (Unlisted Items, Contingency, Engineering) were revised to be a percent of the total field cost and not a continual sum as presented in the HKM study. The 2022 cost assessment adjusted the 2007 figures. The line items adjusted include the penstock cost, Canal conveyance improvements, irrigation re-alignment, and total pipe drop

[9] (HKM Engineering, 2007)

irrigation installed. The Hydropower Unit Capital costs assumed $2,000 per kW for the Drops 1-3, 4, and 5 measure and $2,500 per kW for the Drop 5 Single plant measure. The capital costs are based on bid prices for similar sized hydropower plants designed by HDR. Updated transmission costs were also included in the revised calculations. Transmission costs were estimated to be $300,000 per mile based bid prices for multiple transmission projects with similar power capacities in Colorado and the Northwest. The transmission costs were increased for the measure constructing smaller power plants at 3 separate locations to account for connecting all three plants to a single transmission line. Engineering and contingency costs were updated to reflect the work required to design the entire hydropower project instead of just design of the hydropower plant. Annual O&M costs were increased to 2.5% in an attempt to adjust for the ongoing changes in labor, fuel, and materials costs. Table D3-21 shows the results of the current cost analysis.

Table D3-21. Revised Hydropower Cost Assessment

	Drops 1-3 (4.5 MW) Drop 4 (3.3 MW) Drop 5 (2.9 MW) Flow: 850 cfs (2022 Pricing)	Drop 1-5 (10.6 MW) Flow: 850 cfs (2022 Pricing)
Hydropower Unit Capital Cost	$21,100,000	$26,375,000
Total Penstock Cost	$9,741,581	$4,453,294
Canal Conveyance Improvements	$5,297,089	$5,297,089
Irrigation Re-alignment	$0	$10,717,258
Total Pipe Drop Installed	$13,453,360	$13,453,360
Transmission Cost	$11,400,000	$12,400,000
Unlisted Items (10%)	$6,099,203	$7,269,600
Contingency (20%)	$13,418,247	$15,993,120
Engineering (20%)	$13,418,247	$15,993,120
Total Cost	$93,927,726	$111,951,842
Total Hydropower Cost	$61,794,144	$63,951,254
Annual O&M Costs	$1,544,854	$1,598,781

Based on the total hydropower cost the financial viability was evaluated for each measure. As a simplified financial analysis of the project the payback period was calculated using a zero-discount rate. The analysis accounted for ongoing O&M costs but did not include adjustments for the changing interest rates over time. The revenue assumed a price of $0.035 per kW based on the rates published by Northwestern Energy for avoided energy and capacity being supplied by the project. The results of the analysis are shown in Table D3-22. The payback periods using revised 2022 figures for the Drops 1-5 measure is more than 1,000 years and revenue from the Drop 5 single plant measure only covers the estimated O&M annual costs. It is possible that there may be opportunities to mitigate the costs associated with the hydropower development using grants, tax incentives, and other funding sources. These were not included in the analysis because it is unknown how these opportunities may be applied without completing discussions with the Blackfeet Tribe, Reclamation, and the MRJBOC focused on how they might proceed with development of hydropower at this site. In addition, HDR met with Tribal representatives on October 6, 2022, and were informed that Blackfeet do not currently see the project as financially viable and are not interested in pursuing the project at this time.

Equipment prices and construction costs are extremely volatile in the current market. Many equipment prices are also being adversely affected by the challenges with shipping – especially from overseas manufacturers. All of these items combine with the potentially lengthy schedule for obtaining the required licenses and permits for a hydropower facility to contribute to project uncertainty.

Table D3-22. Financial Analysis

	Total Project Costs	Price Per kWh	O & M Costs	Annual Revenue	Annual Profit
Drops 1-3 (4.5 MW) Drop 4 (3.3 MW) Drop 5 (2.9 MW) Flow: 850 cfs (2022 Pricing)	$93,927,726	$1.81	$1,544,854	$1,600,106	$55,252
Drop 1-5 (10.6 MW) Flow: 850 cfs (2022 Pricing)	$111,951,842	$2.53	$1,598,781	$1,600,106	$1,325

D3.5 Measure Screening and Alternative Refinement

Each of the measures were screened for their reasonableness under NEPA and under the PR&G criteria. The summary table in Attachment A provides an evaluation of each measure.

MRJBC, Reclamation, Farmers Conservation Alliance (FCA) and HDR met on August 25, 2022, and August 29, 2022, to discuss the measures and reach a consensus on the preferred measures moving forward. Meeting notes from these meetings are included in Appendix B. During these meetings the following measures were selected:

1. Canal Conveyance – A hybrid approach from the measures considered including using an improved earthen Canal section and an improved earthen Canal section with a geosynthetic liner.
2. Siphon Replacements – Full replacement of the siphons with a buried installation and bid measures for either steel pipe or concrete cylinder pipe (CCP).

3. Wasteways/Turnouts (Drains) - Replace the existing Kennedy Creek and Halls Coulee Wasteways with new improved structures to include evaluating different gate configurations for the new structures, automation, etc. during design. Improvements also include the replacement of existing drains with new side channel spillway structures.
4. Underdrains (Culverts) – Underdrains will be replaced and upgraded to convey the 25-year event.
5. Slope Stability (Active Slide Area) – Slope stability is somewhat dependent on geotechnical site investigations. The known areas with slope stability concerns along the Canal will be addressed with an earthwork option. For each slide area this includes:
   A. Removing weight off the top of the slides to the extent possible by flattening the exposed slopes.
   B. Relocate excavated material, place and compact on the downhill side of the Canal.
   C. Control of subsurface and surface water will also be addressed in the form of filter drains or surface swales to direct as much water as possible away from the unstable soils.
6. Drop Structures – Drop structures 1, 3, and 4 will be replaced by new structures with a similar design to the recently replaced drop structures 2 and 5.
7. Maintenance Road – The existing access road running along the Canal alignment will be improved. Drainage will be evaluated, and drainage improvements (culverts) may also be included where appropriate.
8. Animal Intrusion – No consensus was reached on a selected measure to address potential animal intrusion concerns. It was agreed that HDR will expand on animal intrusion in the SIP and provide costs for fencing both sides of the Canal.

Based on these selected measures, two action alternatives were established for detailed study. Table D4-22 describes the combination of canal modification measurers that were used to established St. Mary Canal System modernization alternatives. This table includes the No Action Alternative as required for analysis in the Watershed Plan-EIS.

Table D3-23. Alternatives Carried Forward for Detailed Study

Alternative	Measure	Measure Description
Alternative 1 – No Action (future without Federal investment)	No improvements	No Watershed Project would be implemented, and the St. Mary Canal and associated infrastructure would not be modernized.
Alternative 2 (Line/Reshape + All other Measures)	Canal Conveyance	This option would line the Canal with a geosynthetic liner from the St. Mary Diversion to the St. Mary Siphon intake. Additionally, reshape St. Mary's Diversion to St. Mary Siphon intake, reshape St. Mary Siphon outlet to Halls Coulee Siphon inlet and Halls Coulee outlet to Drop 1 intake. Includes improving the existing embankment to at least establish the minimum required freeboard in the canal and constructing a new embankment on the "uphill" side of the canal where there is no embankment now.
	Siphon Modification	Kennedy Creek Siphon would be modified to include the installation of a 10-foot by 10-foot RCB adjacent to the existing siphon, which would be rehabbed.
	Drop Structure Replacement	Piped or Concrete Conveyance on either East or West Alignment: This option would reconstruct Drop Structures 1, 3, and 4 on either the east or west side of the existing alignment.
	Slope Stability (Slide Mitigation)	Soil Injection Stabilization: A combination of concrete and other compounds is injected into the slide area to stabilize the slide.
		Buried Conveyance: The canal would be buried in a box culvert (or similar structure) for the length of the slide area.
		Earthwork Mitigation: All slides would be stabilized via earth-moving techniques
	O&M Road Improvements	Improve existing maintenance road to 12-ft. wide on north side of canal.
	Wasteway, Spillways, and Drains	Replace Kennedy Creek and Hall Coulee wasteways with improved structures. Includes evaluating different gate configurations for the new structures, automation, etc. Replace existing drains with new side channel spillway structures.
	Underdrains (Culverts)	All underdrains would be replaced and have their capacity expanded to handle a 25-year event

Alternative	Measure	Measure Description
Alternative 3 (Reshape + All Measures Remain the Same as under Alternative 2)	Canal Conveyance	Reshape St. Mary's Diversion to St. Mary Siphon intake, reshape St. Mary Siphon outlet to Halls Coulee Siphon inlet and Halls Coulee outlet to Drop 1 intake. Includes improving the existing embankment to at least establish the minimum required freeboard in the canal and constructing a new embankment on the "uphill" side of the canal where there is no embankment now. No lining would be installed in the Canal.
	Siphon Modification	Kennedy Creek Siphon would be modified to include the installation of a 10-foot by 10-foot RCB adjacent to the existing siphon, which would be rehabbed.
	Drop Structure Replacement	Piped or Concrete Conveyance on either East or West Alignment: This option would reconstruct Drop Structures 1, 3, and 4 on either the east or west side of the existing alignment.
	Slope Stability (Slide Mitigation)	Soil Injection Stabilization: A combination of concrete and other compounds is injected into the slide area to stabilize the slide.
		Buried Conveyance: The canal would be buried in a box culvert (or similar structure) for the length of the slide area.
		Earthwork Mitigation: All slides would be stabilized via earth-moving techniques.
	O&M Road Improvements	Provide for a post-construction condition of the existing maintenance road to a 12-ft. wide with gravel surface..
	Wasteways, Spillways, and Drains	Replace Kennedy Creek and Hall Coulee wasteways with improved structures. Includes evaluating different gate configurations for the new structures, automation, etc. Replace existing turnouts with 9 new side channel spillway structures.
	Underdrains (Culverts)	All underdrains would be replaced and have their capacity expanded to handle a 25-year event.

Attachment A Supporting Info

Range of Management Measures for St. Mary Canal Modernization Plan-EIS

Project Purpose: The purpose of this watershed plan is to alleviate damages to irrigated agriculture and agricultural communities served by the Milk River Project due to the unreliable access to St. Mary River water.

Management Measures	Option Description	Screening Methodology	*Screening Results*				
			Purpose and Need	Reasonableness (NEPA)	Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	PR&G (Completeness, Effectiveness, Efficiency, Acceptability)	Disposition of Options (Consideration for More Detail Study or Elimination)
Canal Modernization							
Canal Conveyance (St. Mary Canal Intake to Drop 1)	No Action/Future Without Federal Investment This option is the most likely course of action should the Sponsor not receive Federal funding for the Project. In this option, no Federal assistance would be available, and the Sponsor would not pursue further action.	Restore canal to original design capacity of 850 cfs. by improving efficiency of flow conveyance through reduced evaporation, reduced surface area, and reduced seepage.	Option would not meet purpose and need.	NA	NA	NA	Option does not meet purpose and need but will be carried forward into the No Action Alternative.
	Line Canal with Geosynthetic Liner This option would line the Canal with a geosynthetic liner from the St. Mary Diversion to the St. Mary Siphon intake.		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable.	Option meets PR&Gs.	Carried forward for consideration for inclusion within an Alternative.
	Line Canal with Concrete This option would line the Canal with concrete from the St. Mary's Canal intake to the St. Mary Siphon intake.		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable.	Effectiveness and Efficiency - Costs, freeze/thaw environment and higher O&M costs for maintenance of a concrete lined channel make this a difficult modernization option to proceed with.	Eliminated due to not meeting the Efficiency standards set forth in the PR&G screening criteria.
	Replace Open Canal with Closed Pipe Conveyance This option consists of piping the reaches of the canal between the existing siphon crossings. The option would require new alignments of the canal and new right-of-way and easements.		Option would meet purpose and need.	Option is cost prohibitive.	Option is not practicable due to cost.	Efficiency – Based on modeling, it was determined that three 10-foot barrels will be required to convey the required design flows. Installing three 10-foot barrels over 25 miles is over 400,000 linear feet. Not including fittings and other requirements to install this amount of the cost approaches one billion dollars with contingency.	Eliminated due to reasonableness and logistics of a new alignment with a large amount of new ROW needed.
	Reshape Canal Reshape St. Mary's Diversion to St. Mary Siphon intake, Reshape St. Mary Siphon outlet to Halls Coulee Siphon inlet and Halls Coulee outlet to Drop 1 intake. Includes improving the existing embankment to at least establish the minimum required freeboard in the canal and constructing a		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable.	Option meets PR&Gs.	Carried forward for consideration for inclusion within an Alternative.

Management Measures	Option Description	Screening Methodology	Screening Results				
			Purpose and Need	Reasonableness (NEPA)	Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	PR&G (Completeness, Effectiveness, Efficiency, Acceptability)	Disposition of Options (Consideration for More Detail Study or Elimination)
Canal Modernization							
	new embankment on the “uphill” side of the canal where there is no embankment now.						
	Canal Realignment Includes improving the existing embankment to establish the minimum required freeboard in the canal and constructing a new embankment on the “uphill” side of the canal where there is no embankment now.		Option would not meet purpose and need as it would be off alignment	Option would not be reasonable due to ROW acquisition and costs.	NA	NA	Eliminated due to not meeting purpose and need as it would be off the existing canal alignment.
Canal Conveyance	Maintain Existing St. Mary Canal System This option would maintain the canal to convey less than 850 cfs.	Maintains canal capacity at or near existing infrastructures operating limits.	Option would not meet purpose and need.	Option would not be reasonable due to not meeting the allocated water right.	NA	NA	Option does not meet the purpose and need. Option would not deliver the total allocated water right.
Siphon Modification (Kennedy Creek Crossing)	No Action/Future Without Federal Investment This option is the most likely course of action should the Sponsor not receive Federal funding for the Project. In this option, no Federal assistance would be available, and the Sponsor would not pursue further action	Maintains as-built design capacity of 850 cfs.	Option would not meet purpose and need.	NA	NA	NA	Option does not meet purpose and need but will be carried forward into the No Action Alternative.
	Replace in Current Condition This option would consist of construction of pipes, bridges, and inlet/outlet structures.		Option would meet purpose and need.	Option is not reasonable to implement due to the requirement of construction during the winter months in order to be in service by spring to meet water user demands.	Option is not practicable. Cost - Expected construction costs for this option are significantly higher than for the other options being considered.	Efficiency - Expected construction costs for this option are significantly higher than for the other options being considered.	Eliminated due to reasonableness cost and efficiency of the option to meet the purpose and need.
	Replace Above Ground Construction This option would include full replacement of the existing siphons with either single or twin above grade pipes to the south of the existing siphons with a new inlet and outlet structures, and a new single span bridge over the St. Mary River		Option would meet purpose and need.	Option is not reasonable to implement due to the significant additional construction costs.	Option is not practicable. Cost - Above Ground Construction requires an additional $2 to $5 million in cost to address pipe movement from thermal expansion at both siphons and the impacts of unstable	Efficiency - Above Ground Construction requires an additional $2 to $5 million in cost to address pipe movement from thermal expansion at both siphons and the impacts of unstable	Eliminated due to cost and efficiency of the option to meet the purpose and need.
	Additional Culvert Installed Adjacent to Siphon Install an additional 10-foot by 10-foot culvert parallel to the existing siphon.		Option would meet purpose and need	Option is reasonable to implement.	Option is practicable.	Option meets PR&Gs.	Carried forward for consideration for inclusion within an Alternative.

Management Measures	Option Description	Screening Methodology	*Screening Results*				
			Purpose and Need	Reasonableness (NEPA)	Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	PR&G (Completeness, Effectiveness, Efficiency, Acceptability)	Disposition of Options (Consideration for More Detail Study or Elimination)
Canal Modernization							
Drop Structure Replacement (Structures 1, 3, and 4)	No Action/Future Without Federal Investment This option is the most likely course of action should the Sponsor not receive Federal funding for the Project. In this option, no Federal assistance would be available, and the Sponsor would not pursue further action	Maintains original design capacity of 850 cfs. and provides safe and reliable continued operation of the Canal within the current right-of-way.	Option would not meet purpose and need	NA	NA	NA	Option does not meet purpose and need but will be carried forward into the No Action Alternative.
	Reconstruct the structure in the original footprint – Steel Insert This option would cover the existing concrete with a prefabricated steel flume insert.		Option would meet purpose and need	Option is not reasonable to implement as construction would need to occur during the winter months and construction costs would be significantly higher than other options.	Option is not practicable. Cost - Expected construction costs for this option are significantly higher than for the other options being considered.	Effectiveness - Placement of a steel insert does not address uncertainty of soil stability and voids under the existing structure and connection of the steel to the existing concrete could be a challenge.	Eliminated due to significant additional costs associated with winter construction and not meeting the Effectiveness standards set forth in the PR&G criteria.
	Reconstruct the structure in the original footprint – Concrete Overlay This option would reconstruct the structure by placing new reinforced concrete over the existing structure.		Option would meet purpose and need	Option is not reasonable to implement as construction would need to occur during the winter months and construction costs would be significantly higher than other options.	Option is not practicable. Cost - Expected construction costs for this option are significantly higher than for the other options being considered.	Effectiveness – Does not address the integrity of the concrete in the existing drop structure.	Eliminated due to significant additional costs associated with winter construction and not meeting the Effectiveness standards set forth in the PR&G criteria.
	Reconstruct the structure in the original footprint – Headwall and Pipes This option would build a headwall at the upstream end of the existing concrete chute. Four pipes would be installed on top of the existing concrete chute and reconstruct the existing stilling basin.		Option would meet purpose and need	Option is not reasonable to implement as construction would need to occur during the winter months and construction costs would be significantly higher than other options.	Option is not practicable. Cost - Expected construction costs for this option are significantly higher than for the other options being considered.	Effectiveness - Use of a new headwall and pipes requires some demolition of the existing structure, the pipe will need thrust blocks that would be placed on top of the existing structure, and the stilling basin would need to be redesigned to accommodate flow from the pipes.	Eliminated due to significant additional costs associated with winter construction and not meeting the Effectiveness standards set forth in the PR&G criteria.
	Reconstruct the structure in the original footprint – Reconstruct In Kind This option would fully reconstruct the spillway chute and stilling basin in the existing location.		Option would meet purpose and need	Option is not reasonable to implement as construction would need to occur during the winter months and construction costs would be significantly higher than other options.	Option is not practicable. Cost - Expected construction costs for this option are significantly higher than for the other options being considered.	Efficiency – Cost is significantly higher than other options considered.	Eliminated due to significant additional costs associated with winter construction and not meeting the Effectiveness standards set forth in the PR&G criteria.
	Replacement Structure – Piped or Concrete Conveyance on either East or West Alignment		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable.	Option meets PR&G criteria.	Carried forward for consideration for inclusion within an Alternative

Management Measures	Option Description	Screening Methodology	Screening Results				
			Purpose and Need	Reasonableness (NEPA)	Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	PR&G (Completeness, Effectiveness, Efficiency, Acceptability)	Disposition of Options (Consideration for More Detail Study or Elimination)
Canal Modernization							
	This option would reconstruct the structure to either the east or west of the existing alignment.						
Post-construction O&M Road	No Action/Future Without Federal Investment This option is the most likely course of action should the Sponsor not receive Federal funding for the Project. In this option, no Federal assistance would be available, and the Sponsor would not pursue further action	Provides suitable post-construction access to maintain canal operations for necessary operation and maintenance.	Option would not meet purpose and need.	NA	NA	NA	Option does not meet purpose and need but will be carried forward into the No Action Alternative.
	Post-construction access Road on One Side of Canal Provide a post-construction condition of the existing maintenance road to 12-ft. wide gravel surface on one side (primary construction access) of the canal.		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable.	Option meets PR&G criteria.	Carried forward for consideration for inclusion within an Alternative.
	Post-construction Access Road on Both Sides of Canal Provide a post-construction condition of the existing maintenance road to 12-ft. wide gravel surface on one side (primary construction access) of the canal and construct maintenance on the opposite side of canal.		Option would meet purpose and need.	Option is potentially reasonable to implement, however would be a challenge due to cost, logistics, ROW, and long-term maintenance.	Cost, logistics, ROW, and long-term maintenance would all be challenges with this option.	Acceptability – Acquiring additional right-of-way would be a challenge due to landowner opposition. Efficiency – Cost is more than doubled increased cost for subgrade preparation to establish a new O&M road on the opposite side of the canal from the existing O&M road. Relatively infrequent need to access the other side of the canal, it was decided that improvements to the existing access road are sufficient.	Eliminated due to not meeting the Acceptability and Efficiency standards set forth in the PR&G criteria.
Wasteways, Spillways, and Drains	No Action/Future Without Federal Investment This option is the most likely course of action should the Sponsor not receive Federal funding for the Project. In this option, no Federal assistance would be available, and the Sponsor would not pursue further action	Provides ability to maintain maximum design capacity flow within canal system.	Option would not meet purpose and need.	NA	NA	NA	Option does not meet purpose and need but will be carried forward into the No Action Alternative.
	Full Replacement of Wasteways and Turnouts Replace the existing Kennedy Creek and Halls Coulee Wasteways in kind. Replace existing turnouts with new turnouts. The new turnouts would include concrete inlet		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable	Effectiveness – Wasteways in kind would not improve emergency response capabilities. Capacity of the existing turnouts is unknown, and therefore, a reasonable design capacity was established as the basis for the side channel spillway design.	Eliminated due to not meeting Efficiency standard set forth in PR&G criteria.

Management Measures	Option Description	Screening Methodology	Screening Results				Disposition of Options (Consideration for More Detail Study or Elimination)
			Purpose and Need	Reasonableness (NEPA)	Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	PR&G (Completeness, Effectiveness, Efficiency, Acceptability)	
Canal Modernization							
	structures with slide gates, pipes, and concrete outlet structures designed to function similar to the existing turnouts.						
	Improved Replacement of Wasteways and Turnouts Replace wasteways improved structures. Includes evaluating different gate configurations for the new structures, automation, etc. Replace existing turnouts with 9 new side channel spillway structures.		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable.	Option meets PR&G criteria.	Carried forward for consideration for inclusion within an Alternative.
	Improved Replacement of Wasteways and Turnouts, Add New Structures Replace wasteways improved structures. Includes evaluating different gate configurations for the new structures, automation, etc. Replace existing turnouts with new side channel spillway structures. Seven additional side channel spillway structures would be added along the St. Mary Canal.		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable.	Efficiency – Additional spillway structures were not determined to be required and therefore are not a needed expense to meet the project intent.	Eliminated due to not meeting Efficiency standard set forth in PR&G criteria.
Underdrains (Culverts)	No Action/Future Without Federal Investment This option is the most likely course of action should the Sponsor not receive Federal funding for the Project. In this option, no Federal assistance would be available, and the Sponsor would not pursue further action	Meets headwater criteria developed by the Montana Department of Transportation 25-year design event.	Option would not meet purpose and need.	NA	NA	NA	Option does not meet purpose and need but will be carried forward into the No Action Alternative.
	Improved replacement All underdrains would be replaced and have their capacity expanded to handle a 25-year event		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable.	Option meets PR&G criteria.	Carried forward for consideration for inclusion within an Alternative
	Replace to Match Original Design All underdrains would be replaced with structures that match their original design.		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable.	Effectiveness – Original design would not meet the recommended design storm event.	Eliminated due to not meeting the Effectiveness standard set forth in the PR&G criteria.
	Add Underdrains (Culverts) Underdrains would be added in certain locations		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable.	Efficiency – Additional underdrains were not determined to be required and therefore are not a needed expense to meet the project intent.	Eliminated due to not meeting Efficiency standard set forth in PR&G criteria.

Management Measures	Option Description	Screening Methodology	*Screening Results*				
			Purpose and Need	Reasonableness (NEPA)	Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	PR&G (Completeness, Effectiveness, Efficiency, Acceptability)	Disposition of Options (Consideration for More Detail Study or Elimination)
Canal Modernization							
Slope Stability (Slide Mitigation)	No Action/Future Without Federal Investment This option is the most likely course of action should the Sponsor not receive Federal funding for the Project. In this option, no Federal assistance would be available, and the Sponsor would not pursue further action	Reduces the risk of canal operation failure due to slide impacts. NOTE: Screening at this phase is course. Options that meet screening will be reviewed on a site-by-site basis with geotechnical information to inform if an option should be eliminated from consideration or modified.	Option would not meet purpose and need.	NA	NA	NA	Option does not meet purpose and need but will be carried forward into the No Action Alternative.
	Soil Injection Stabilization A combination of concrete and other compounds is injected into the slide area to stabilize the slide.		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable.	Option meets PR&G criteria.	Carried forward for consideration for inclusion within an Alternative.
	Buried Conveyance The canal would be buried in a dual 12-foot concrete box culvert or triple 120-inch RCP for the length of the slide area.		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable.	Option meets PR&G criteria.	Carried forward for consideration for inclusion within an Alternative.
	Earthwork Mitigation All slides would be stabilized via earth-moving techniques		Option would meet purpose and need.	Option is reasonable to implement.	Option is practicable.	Option meets PR&G criteria.	Carried forward for consideration for inclusion within an Alternative.
Animal Intrusion (St. Mary River Diversion to Drop 1 Intake)	No Action/Future Without Federal Investment This option is the most likely course of action should the Sponsor not receive Federal funding for the Project. In this option, no Federal assistance would be available, and the Sponsor would not pursue further action	Target a primary species of interest for effectiveness of best practices for exclusion.	Option would not purpose and need.	NA	NA	NA	Option does not meet purpose and need but will be carried forward into the No Action Alternative.
	Fencing both sides of the canal from the St. Mary River diversion structure to the Drop 1 intake area is to limit and control access to the canal by wildlife and livestock animals. Install small pond or watering tank.		Option would not meet purpose and need.	Option is not reasonable to implement with anticipated ROW challenges.	Option is not practicable to implement due to landowner opposition.	Acceptability – Landowners have voiced opposition to fencing options. This option does not meet the Acceptability criteria.	Eliminated due to not meeting purpose and need. Additionally, option does not meet the Acceptability standard set forth in the PR&G criteria.
Hydropower (Drop Structures 1-5)	No Action/Future Without Federal Investment This option is the most likely course of action should the Sponsor not receive Federal funding for the Project. In this option, no Federal assistance would be available, and the Sponsor would not pursue further action	Must meet all Reclamation and tribal considerations and an applicable power supplier willing to buy power for incorporation into the power pool.	Option would not meet purpose and need.	NA	NA	NA	Option does not meet purpose and need but will be carried forward into the No Action Alternative.

Management Measures	Option Description	Screening Methodology	*Screening Results*				
			Purpose and Need	Reasonableness (NEPA)	Practicability (Cost, Logistics, Technology – 404(b)(1) Guidelines)	PR&G (Completeness, Effectiveness, Efficiency, Acceptability)	Disposition of Options (Consideration for More Detail Study or Elimination)
Canal Modernization							
	Hydropower through the five drop structures at the end of the St. Mary Canal. Penstock, canal conveyance improvements, irrigation realignment, and transmission.		Option would not meet purpose and need.	Option is not reasonable to implement due to concerns with cost and ROW.	Option is not reasonable to implement due to concerns with cost and ROW (logistics).	Acceptability – The Blackfeet Tribe have exclusive rights to develop and market hydropower on the St. Mary Unit according to the Blackfeet Water Rights Settlement Act of 2016. The Blackfeet Tribe generally not been interested in pursuing hydropower. Since the project is located entirely within the Blackfeet Reservation, this does not meet the Acceptability criteria.	Eliminated due to not meeting purpose and need. Additionally, option does not meet the Acceptability standard set forth in the PR&G criteria.

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Appendix D4. Historic Properties and Cultural Resources Documents

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Class III Cultural Resource Survey for Milk River St. Mary Canal Improvements Project

Glacier County, Montana

HDR

369 Inverness Pkwy., Suite 325

Englewood, CO 80112-6011

(303) 754-4200

NRCS PROJECT NO.

NR220325XXXXC001

TYPE OF WORK

Cultural Survey

PRINCIPAL INVESTIGATOR

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AUTHOR(S)

Paul H. Buckner, MA, RPA

Lars Boyd, MA, RPA

Andrew Mueller, PhD, RPA

DATE: April 01, 2024

D4.1 Abstract

The Milk River Joint Board of Control (MRJBOC) proposes to rehabilitate elements of the St. Mary Canal in Glacier County, Montana, as part of the St. Mary Canal Modernization Project (Project). Following emergency repairs to Drop 2 and Drop 5 of the St. Mary Canal in 2020, the MRJBOC initiated the proposed Project to proactively rehabilitate existing siphons, drop structures, and wasteways along 29 miles of the canal. Structurally deficient structures that require repair or replacement are the Kennedy Creek Siphon, the St. Mary River Siphon, the Halls Coulee Siphon, the Kennedy Creek Wasteway and Check, Spider Lake Check Dam, the Halls Coulee Wasteway, and Drops 1, 3, and 4. The proposed Project has received funding from the Natural Resources Conservation Service (NRCS) and accordingly constitutes a federal undertaking under the National Historic Preservation Act (NHPA) (1966, as amended in 2000), and its implementing regulations at Code of Federal Regulations (CFR) Title 36 Part 800. The NHPA requires federal agencies to consider the potential effects of an undertaking on "historic properties," which are defined as cultural resources that are listed in, or eligible for inclusion in, the National Register of Historic Places (NRHP). As part of this process, the lead federal agency must identify cultural resources within the area of potential effect (APE), evaluate the eligibility of these resources for inclusion in the NRHP, and assess potential adverse effects to historic properties. The NRCS is serving as the lead federal agency for this undertaking while the BOR has been identified as a cooperating agency. HDR Engineering, Inc., (HDR) was contracted to complete a Class III cultural resource survey for the Project to assist MRJBOC, NRCS, and Bureau of Reclamation (BOR) in meeting their responsibilities under NHPA.

The NRCS has determined that environmental impacts from the Project are likely to be significant and has accordingly published a notice of intent (NOI) to prepare a Watershed Plan-Environmental Impact Statement (Plan-EIS). The Plan-EIS would assess and disclose the potential effects of the Project and would investigate alternatives to modernize the existing St. Mary Canal and associated infrastructure. The Plan-EIS is required to request federal funding through the Watershed Protection and Flood Prevention Act (P.L. 83-566). Three project alternatives have been proposed. The three alternatives in the Plan-EIS are Alternative 1- No Action, Alternative 2- Canal Modernization and Line/Reshape, and Alternative 3 – Canal Modernization and Reshape. The APE for the EIS is larger than the area surveyed for this report and includes the length of the canal from the St. Mary River to Milk River. NRCS has determined that the archaeological investigations for the project will follow a phased approach, and the initial survey in this report focuses on areas common to Alternatives 2 and 3 where repair and/or replacement of existing features will take place.

HDR completed the Class III cultural resource survey of a portion of the Project APE in November 2023. The survey identified four cultural resources. These include the previously documented St. Mary Canal (24GL155) and a precontact animal processing area (24GL1172) that was first recorded in 2007. Two newly recorded archaeological sites were also recorded, a historic trash dump (24GL1786) and a precontact rock cairn (24GL1787). All resources were evaluated for their eligibility for inclusion in the NRHP. The St. Mary Canal (24GL155) is officially eligible for inclusion in the NRHP, and no additional information was noted to warrant

reconsideration of its eligibility status. Site 24GL1172 was previously recommended eligible for listing in the NRHP under Criterion D and HDR agrees with this previous recommendation. Of the newly documented sites, HDR does not recommend site 24GL1786 as eligible for inclusion in the NRHP under any criteria and its data potential has been exhausted by the current recording. HDR recommends site 24GL1787 as unevaluated for listing in the NRHP pending tribal consultation on its significance under Criterion A. Pending clarification of this eligibility under Criterion A, 24GL1787 should be managed as eligible and avoided by Project impacts.

Based on the criteria for what constitutes adverse effects contained in 36 CFR 800.5, the proposed Project will have an adverse effect on the St. Mary Canal (24GL155) and its associated infrastructure. As currently designed, the Project is also likely to have an adverse effect on buried precontact archaeological deposits associated with 24GL1172. Following concurrence with this effects recommendation, HDR advises the development of a Memorandum of Agreement (MOA), per 36 CFR 800.5, to resolve these adverse effects.

D4.2 Abbreviations and Acronyms

APE	area of potential effects
BOR	United States Bureau of Reclamation
BP	Before Present
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter(s)
CUI	Controlled Unclassified Information
EIS	Environmental Impact Statement
F1	Feature 1
F2	Feature 2
FCA	Farmers Conservation Alliance
FCR	fire-cracked rock
FS	Field Specimen
ft	foot/feet
HABS/HAER	Historic American Buildings Survey and Historic American Engineering Record
HDR	HDR Engineering, Inc.
m	meter(s)
MOA	Memorandum of Agreement
MRJBOC	Milk River Joint Board of Control
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOI	Notice of Intent
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
Plan-EIS	Plan-Environmental Impact Statement
Project	St. Mary Canal Modernization Project
SHPO	State Historic Preservation Office
THPO	Tribal Historic Preservation Office
USGS	United States Geological Survey

D4.3 Project Description

The St. Mary Canal is a 29-mile-long water diversion canal on the Blackfeet Indian Reservation in Glacier County, Montana. The canal conveys water from the St. Mary Diversion Dam on the St. Mary River to the North Fork of the Milk River as part of the Milk River Irrigation System, which irrigates more than 120,000 acres of farmland in north-central Montana. The eight irrigation districts served by the Milk River Irrigation System make up the Milk River Joint Board of Control (MRJBOC). The MRJBOC is responsible for maintaining and modernizing irrigation infrastructure in the Milk River Watershed in collaboration with federal, state, and tribal partners, including the Bureau of Reclamation (BOR), Natural Resources Conservation Service (NRCS), and the Blackfeet Nation. Following emergency repairs to Drop 2 and Drop 5 in 2020, the MRJBOC initiated the St. Mary Canal Modernization Project (Project) to proactively rehabilitate existing siphons, drop structures, and wasteways. Structurally deficient canal structures that require repair or replacement are the Kennedy Creek Siphon, the St. Mary River Siphon, the Halls Coulee Siphon, the Kennedy Creek Wasteway and Check, Spider Lake Check Dam, the Halls Coulee Wasteway, and Drops 1, 3, and 4.

The proposed Project has received funding from the NRCS and constitutes a federal undertaking under the National Historic Preservation Act (NHPA) (1966, as amended in 2000), and its implementing regulations at Code of Federal Regulations (CFR) Title 36 Part 800. The NHPA requires federal agencies to consider the potential effects of an undertaking on “historic properties,” which are defined as cultural resources that are listed in, or eligible for inclusion in, the National Register of Historic Places (NRHP). As part of this process, the lead federal agency must identify cultural resources within the area of potential effect (APE), evaluate the eligibility of these resources for inclusion in the NRHP, and assess potential adverse effects on historic properties. If adverse effects are likely to occur on a historic property, the lead agency must consult with the appropriate State Historic Preservation Office (SHPO) or Tribal Historic Preservation Office (THPO) and identified consulting parties to consider means to minimize, avoid, or mitigate these effects. The NRCS is serving in this capacity as the lead federal agency, while the BOR has been identified as a cooperating agency. The NHPA review for the Project is being conducted concurrently with a review of environmental impacts under the National Environmental Policy Act (NEPA) of 1969.

NRCS has determined that environmental impacts from the Project are likely to be significant and has accordingly published a notice of intent (NOI) to prepare a Watershed Plan-Environmental Impact Statement (Plan-EIS). The Plan-EIS would assess and disclose the potential effects of the Project and would investigate alternatives to modernize the existing St. Mary Canal and associated infrastructure. The Plan-EIS is required to request federal funding through the Watershed Protection and Flood Prevention Act (P.L. 83-566). Three project alternatives have been proposed (Table D4-1).

Table D4-1. Project Alternatives

Project Alternative	Description
1 – No Action	Federal funding through P.L. 83-566 would not be available to implement the project. MRJBOC would continue to operate and maintain the existing system in its current condition. This alternative assumes that modernization of MRJBOC's system to meet the purpose and need of the project would not be reasonably certain to occur. The No Action Alternative is a continuation of standard operating procedures.
2 – Canal Modernization and Line/Reshape	Canal modernization would be implemented, including the lining and reshaping the canal, replacing siphons, drop structures, wasteways/turnouts, underdrains (culverts), mitigating slides, and improving the operation and maintenance roads.
3 – Canal Modernization and Reshape	Canal modernization would be implemented, including reshaping the canal, replacing siphons, drop structures, wasteways/turnouts, underdrains (culverts), mitigating slides, and improving the operation and maintenance roads.

NRCS is the lead federal agency, with BOR and the Montana Department of Natural Resources and Conservation (DNRC) as cooperating agencies for the Plan-EIS. In accordance with NEPA, NRCS is responsible for issuance of a final decision. MRJBOC retained the Farmers Conservation Alliance (FCA) to contribute to the development of this watershed Plan-EIS in coordination with NRCS and BOR. FCA has subcontracted with HDR Engineering, Inc. (HDR) to provide additional EIS support, including completion of a Class III cultural resource survey to comply with NRCS' parallel responsibilities under Section 106 of NHPA and NEPA.

D4.4 Area of Potential Effects Description & Cultural Resources Inventory Area

The APE for the Project consists of the footprint of Alternatives 2 and 3, which totals 1,211 acres. The survey focused on features common to Alternatives 2 and 3 that will be repaired or replaced. Montana NRCS has implemented a phased approach to the Project, and the remainder of the APE will be surveyed prior to construction of the selected Alternative. As currently defined, the APE consists of a 300-foot-wide corridor (150 feet either side of centerline) for the proposed canal, siphon, and wasteway modernizations, a 100-foot-wide corridor (50 feet either side of centerline) on O&M roads requiring modernization, a 1,000-foot-diameter APE centered on Drop Structures 1, 3, and 4, and a 100-foot buffer around the perimeters of proposed material source pits TDC and Burns. It is assumed that turnout and drain locations will fall in the 300-foot APE for the canal modernization. Additional staging areas and laydown yards will likely be required for the Project but have not yet been identified and are not included in the current APE. The APE is subject to be refined through development of NEPA and Section 106 consultation of the selected Alternative.

NRCS Montana has determined that the Plan-EIS will follow a phased approach for the cultural resource surveys; the current survey focused on the common areas in Alternatives 2 and 3 where repair and/or replacement of existing structures is recommended. The future phases of cultural resources inventory work will focus on the broader portions of the Plan-EIS APE, as described above, that were not examined during previous research or this current study. The future inventory work will be completed ahead of construction activities associated with the selected Alternative from the Plan-EIS.

For the current undertaking, NRCS defined the cultural resources inventory area as a 136-acre area that consists of nine discontinuous survey areas along the 29-mile length of the St. Mary Canal. This study area encompasses the area of potential ground disturbance for Alternatives 2 and 3. The surveyed portion of the study area included the existing canal structures that require repair or replacement: the Kennedy Creek Siphon, the St. Mary River Siphon, the Halls Coulee Siphon, the Kennedy Creek Wasteway and Check, the Spider Lake Check Dam, the Halls Coulee Wasteway, and Drops 1, 3, and 4.

Table D4-2. Individual Survey Areas in the Cultural Resources Inventory Area

Survey Area	Structure	Surface Ownership	PLSS Location	APE Buffer	Acres
1	Kennedy Creek Siphon	BOR	T36N R14W Section 3, L4, L11	300 ft	4.4
2	Kennedy Creek Wasteway and Check	BOR	T36N R14W Section 3, L4, L9	300 ft	2.5
3	St. Mary River Siphon	Private, BOR	T37N R13W Section 19, SESW, L4, L3 T37N R13W Section 30, NWNW, L7	300 ft	31.3
4	Spider Lake Check Dam	Private	T37N R13W Section 21, L2	300 ft	2.5
5	Halls Coulee Wasteway	Blackfeet Nation (Trust Land)	T37N R12W Section 19, L2	300 ft	2.4
6	Halls Coulee Siphon	Blackfeet Nation (Trust Land)	T37N R12W Section 19, SWNE, NWNE, SENE	300 ft	15.4
7	Drop 1	Private	T37N R11W Section 5, L2, L1, NESE, NWSE	1,000 ft	24.6
8	Drop 3	Private	T37N 11W Section 4, SESW, NESW, NWSE, SWSE	1,000 ft	25.1
9	Drop 4	Private	T37N 11W Section 3, SWSW T37N 11W Section 4, SESE T37N 11W Section 9, NENE T37N 11W Section 10, NWNW	1,000 ft	27.7

Figure D4-1. Project location map

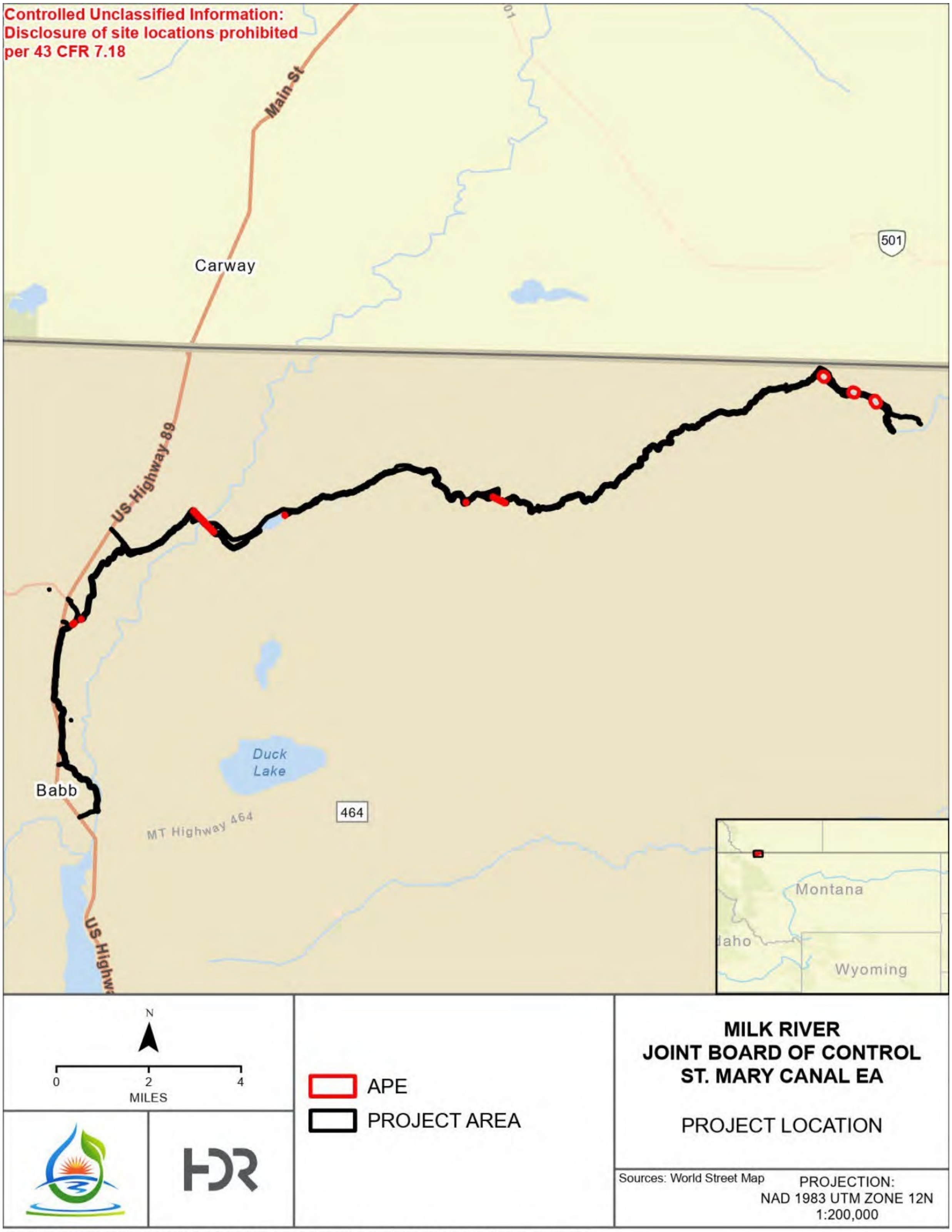

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Figure D4-2. Project location 1:24,000 topographic map (1 of 4)

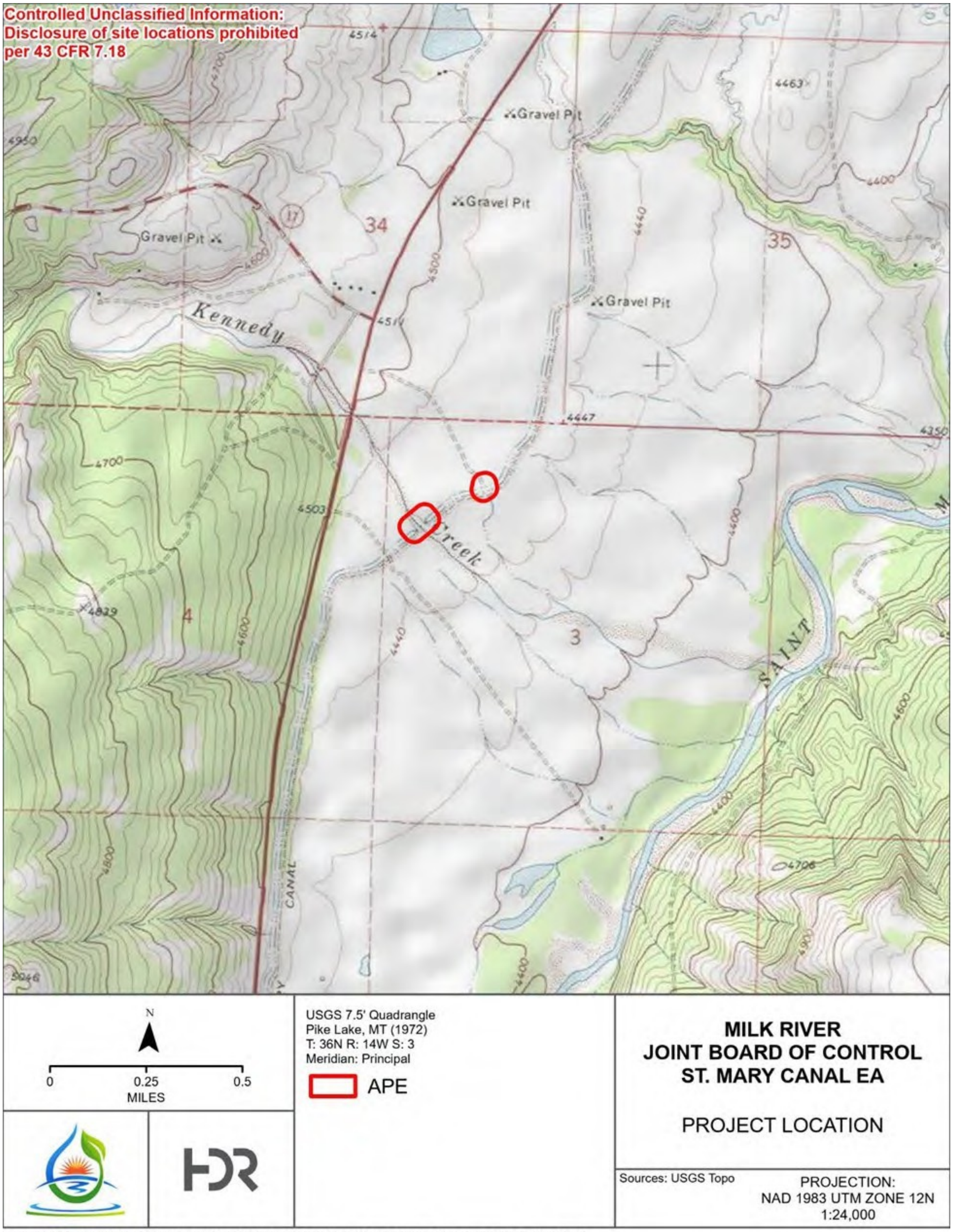

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Figure D4-3. Project location 1:24,000 topographic map (2 of 4)

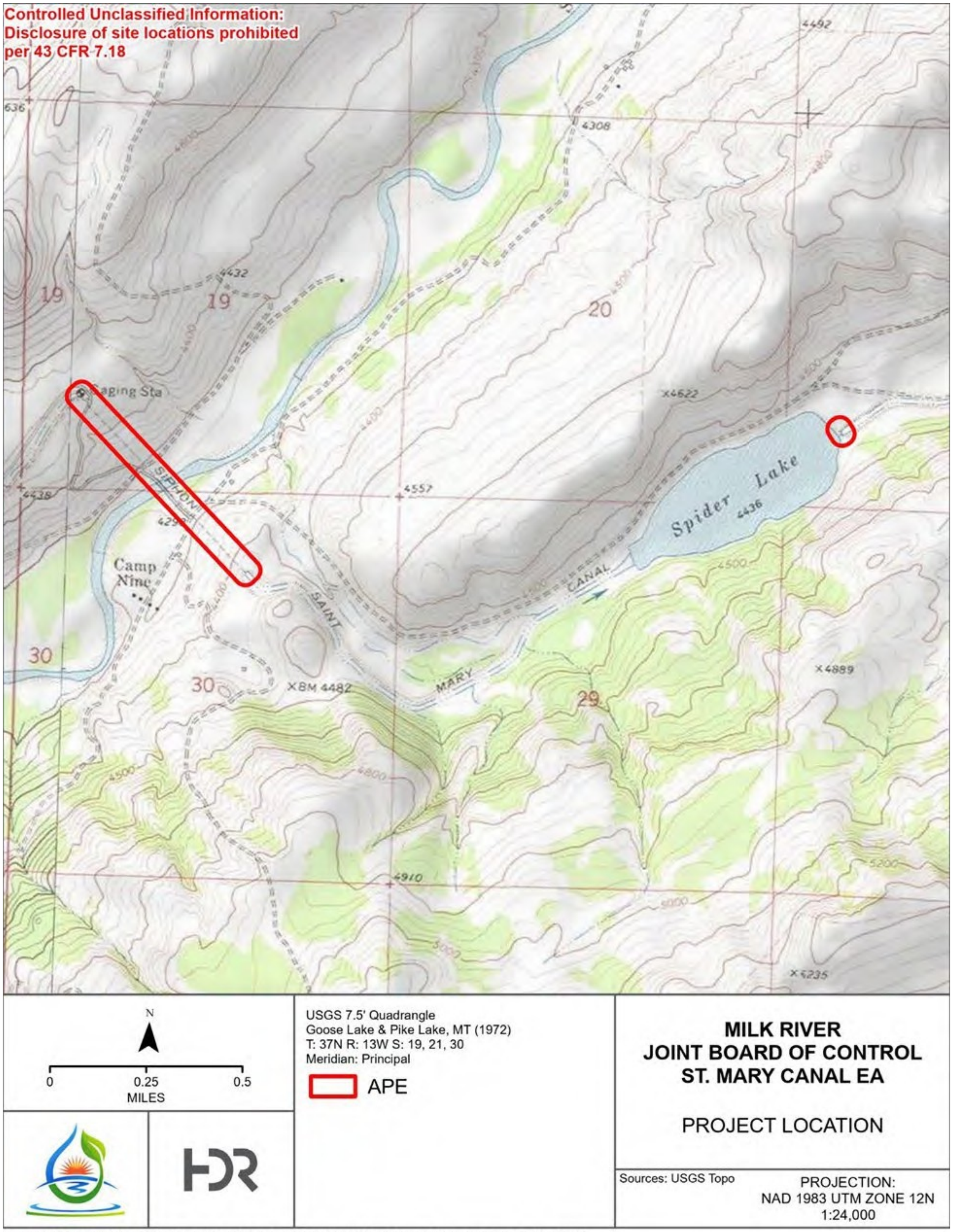

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Figure D4-4. Project location 1:24,000 topographic map (3 of 4)

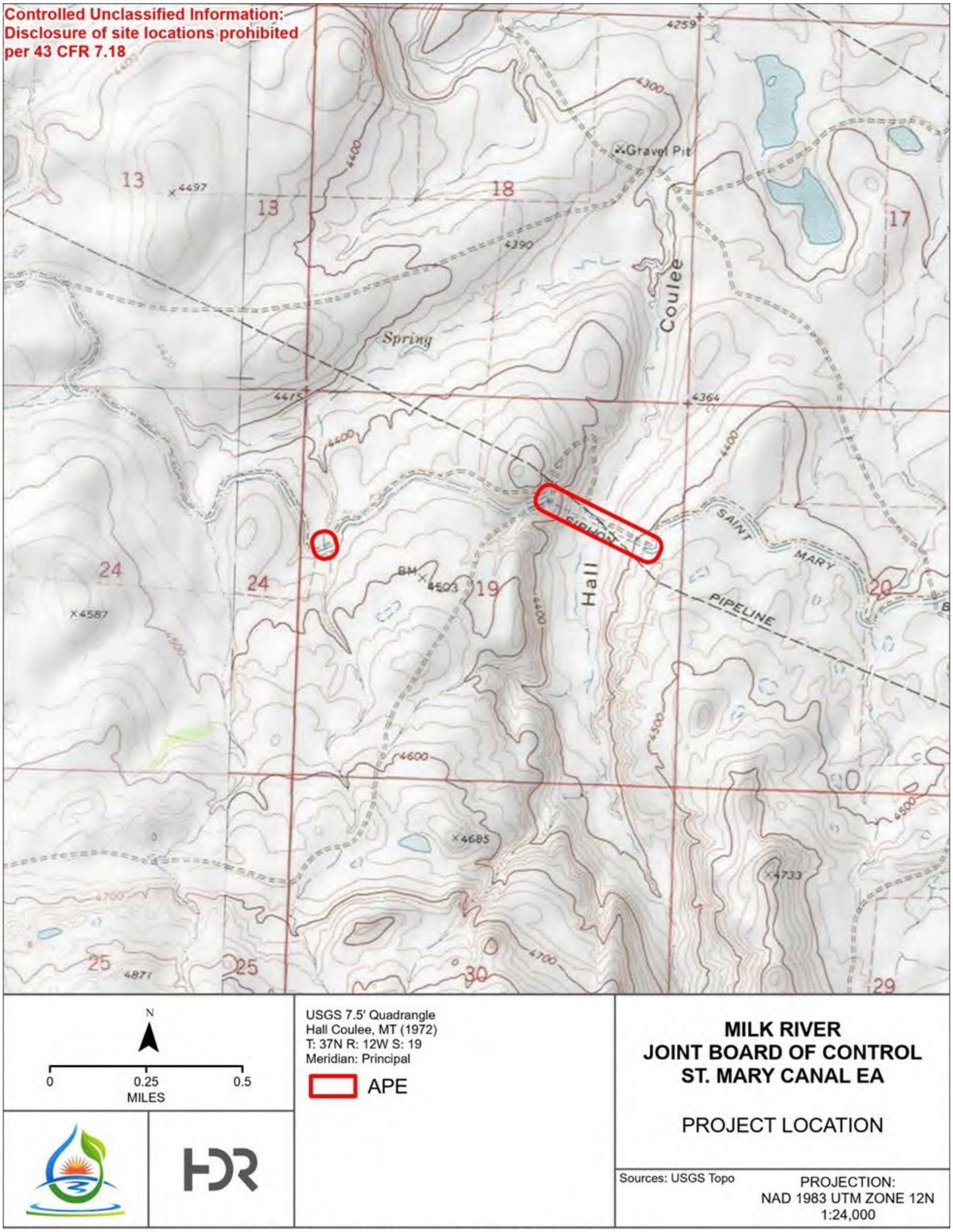

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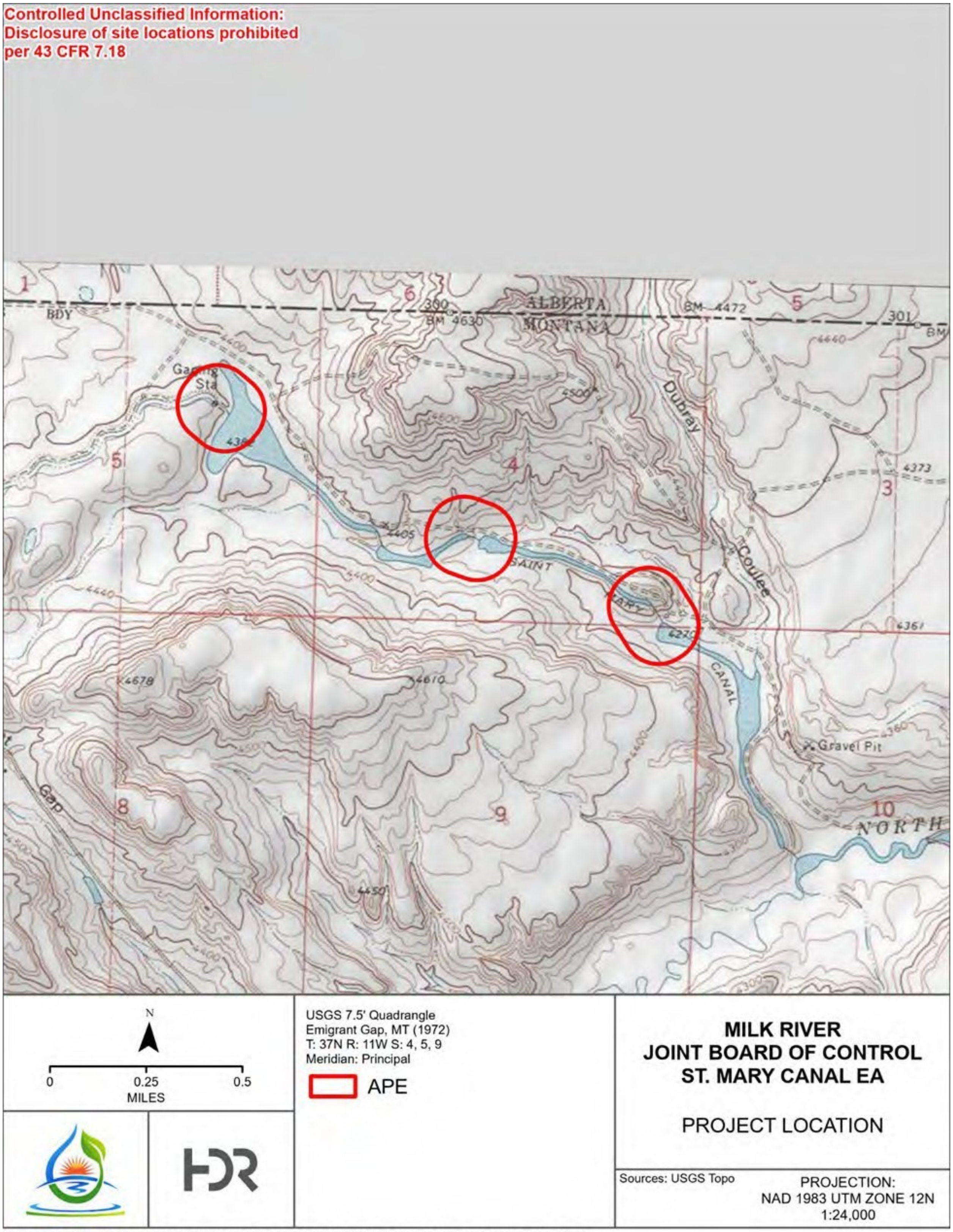
Figure D4-5. Project location 1:24,000 topographic map (4 of 4)



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D4.5 Environmental Setting

D4.5.1 Physiography

The Project area is in Foothill Grassland ecozone of the Northwestern Glaciated Plains. The terrain consists mostly of low relief rolling hills covered with wheatgrass and fescue, with isolated stands of trees along watercourses and in protected areas (Woods et al. 2002). The Project area drains into the St. Mary River at the west end of the APE or the North Fork of the Milk River on the east.

D4.5.2 Soils and Geology

The Project area is in a glaciated landscape containing till deposits from both piedmont and continental glaciers. The western part of the APE near the St. Mary River valley is characterized by Wisconsin-age ground, terminal, lateral, and recessional moraines deposited by piedmont glaciers. These deposits are estimated to have a maximum depth of approximately 15 feet. The remainder of the APE is covered with Wisconsin and Illinoian-age till with a depth of approximately 50 feet near the St. Mary River at the Canadian border (Cannon 1996a). The till is mostly underlain by Upper Cretaceous marine mudstones and sandstones of the Marias River, Two Medicine, St. Mary River, and Willow Creek formations (Cannon 1996b). The predominant soil associations in the APE are the Leavitt Complex, the Babb-Hanson Complex, and wetlands. These are clay to gravelly loams formed in glacial till (NRCS 2023).

D4.5.3 Present Built Environmental Setting

The Project is in a lightly developed area of Glacier County, Montana, on the Blackfeet Indian Reservation. This area of Glacier County is lightly populated apart from widely dispersed homes, ranches, and farms. Near the Project area, most of the rural homes are along Camp Nine Road and Emigrant Gap Road. Babb, Montana, 3.5 miles (5.6 kilometers) to the south of the Project area, has a population of 155 and is the nearest community. Larger population centers in the region include Browning, Montana, 30 miles (48 kilometers) to the south, and Cardston, Alberta, 20 miles (32 kilometers) to the north. The international border between the United States and Canada is close to the Project area and at its nearest point is within 800 feet (243 meters). U.S. Highway 89 is west of the Project area and is the only major roadway in the vicinity. Roads that are directly in the Project area are limited to the St. Mary Canal Road, Camp Nine Road, and unnamed utility roads.

Major industries in this area include tourism and grazing. Grazing activities include both cattle and bison. Tourism is associated with the nearby Glacier and Waterton Lakes National Parks. Current land use is limited to hunting, recreation, water conveyance, and grazing. Major developments in the Project area are limited to the St. Mary Canal and its associated wasteways, siphons, drop structures, and gates.

D4.6 Background Research

D4.6.1 Precontact Context

Archaeological evidence indicates that humans have inhabited the Glacier County area since the late Pleistocene period. Traditional cultural knowledge and oral histories of many Native American Tribes suggest a far longer occupation of the region. The following sections describe the precontact, contact, and post-contact occupation of the area. Figure D4-6 represents the most recent precontact chronology for Montana.

Figure D4-6. Montana precontact chronology

Period		Years ago*	Points/ Culture	Significant Events	Key Sites in Montana
Late Prehistoric		300 1,000	small points Avonlea	Introduction of horse in 1700s First use of bow and arrow	Ulm Pishkun
Archaic	Late Plains	2,000	Besant Pelican Lake	Emergence of Great Plains bison-hunting culture	Wahkpa Chu'gn
Archaic	Middle Plains	3,000 4,000	Oxbow and McKean	Period of transition back to bison hunting	Sun River
Archaic	Early Plains	5,000 6,000 7,000	large side-notched	First pit houses *Bison antiquus* goes extinct First definitive use of atlatl with side-notched point Altithermal, period of hot, dry climate, occurs between 8,000 and 5,000 years ago	Buckeye Myers-Hindman
Paleoindian	Late	8,000 9,000	Foothill/Mountain Cody Agate Basin/ Hell Gap	Intensive bison hunting Increased use of uplands	Mammoth Meadow Barton Gulch KXGN-TV
Paleoindian	Early	10,000 11,000 12,000	Folsom Goshen Clovis	First bison hunters Cooling climate coincides with extinctions of megafauna First people in Montana People on west coast of North America	MacHaffie Mill Iron Anzick

** Based on uncalibrated radiocarbon dates*

Source: Adapted from MacDonald 2012

Paleoindian Period (ca. 12,000 to 8,000 BCE)

The Paleoindian period covers the earliest well-documented human occupation of the region. The evidence of human occupation during this period is sparse, likely due to the dynamic environment that either deeply buried or removed sites via erosion during deglaciation. Surface occupations from this period are rare.

The Paleoindian period in Montana is typically divided into the Early Paleoindian period and Late Paleoindian period. Early Paleoindian complexes include the Clovis, Goshen, and Folsom cultures, while the Foothills/Mountain complex makes up the Late Paleoindian period. In addition, there is evidence of potential pre-Clovis occupation at the Wally's Beach site on the St. Mary River near Cardston, Alberta. The Wally's Beach site is significant not only for its potential pre-Clovis occupation, but because it also contains direct evidence of human hunting of Pleistocene horse (*Equus conversidens*) and camel (*Camelops hesternus*) species (Waters et al. 2015).

Artifacts associated with the site include non-diagnostic stone butchering tools and two Clovis complex projectile points with blood residue proteins from Pleistocene horse and bison (*Bison antiquus*). Though initially assigned to the Clovis complex based on these projectile points, these diagnostic Clovis artifacts were not recovered from secure stratigraphic context and later work has dated the site to circa (ca.) 13,300 Before Common Era (BCE), predating the established chronology for the Clovis complex (MacDonald 2012; Waters et al. 2015).

Some materials observed during previous surveys along the St. Mary Canal appear similar to materials observed at Wally's Beach. The Clovis complex (ca. 10,500 to 10,000 BCE) is the first well-documented archaeological culture on the northern plains, characterized by distinctive finely finished projectile points usually constructed of non-local high-quality materials. Clovis materials are rare in the region apart from one isolated Knife River Flint spearpoint found on an outwash terrace of the Belly River in Glacier National Park.

The following Goshen and Folsom complexes are also rare in northwestern Montana. While Goshen components in Montana are mostly associated with the eastern plains, Folsom sites have been found along the Rocky Mountain Front. These sites include the Indian Creek Site and Machaffie Site (MacDonald 2012). Projectile points from this period are stemmed and lanceolate points generally made from local materials that are less finely finished than projectile points from the preceding Clovis period. Although still rare, there are more sites from this period in the northwestern Great Plains than Clovis, which either indicates an increase in population or environmental conditions more amenable to site preservation.

The final Paleoindian period complex is the Foothill/Mountain complex, which has been observed elsewhere in the Rocky Mountain region (Reeves 2003:60; Kornfeld et al. 2010). The Foothill/Mountain complex is notable because it is associated with a subsistence emphasis on mountain game species, such as bighorn sheep and pronghorn, rather than the bison of the plains (MacDonald 2012). Twelve sites from this period have been located in the nearby Waterton-Glacier park system to the west of the Project area. This period is characterized by finely crafted, obliquely flaked stemmed and lanceolate points (Reeves 2003:60).

Plains Archaic Period (ca. 8,000 to 1,500 BCE)

The Plains Archaic period is marked by a shift from the spearpoints that dominated the previous period to smaller dart points. The period is usually divided into the Early Archaic, Middle Archaic, and Late Archaic. The Early Archaic is marked by Bitterroot and Salmon River side-notched projectile points, while the Middle Archaic sees the addition of Oxbow and McKean Complex projectile points. Oxbow projectile points and McKean Complex projectile points are morphologically similar, and their differentiation in the archaeological literature is more attributable to regional preferences of archaeologists rather than differences in precontact cultures or lithic technology (MacDonald 2012:76-77). The highly fragmentary fire-cracked rock found at sites of this period indicate stone boiling was the most common cooking technology, and the roasting pits commonly associated with McKean sites further south are absent in this area.

The Late Archaic retains many of the technological characteristics associated with the McKean complex, suggesting cultural development in place versus replacement of one group with another. This period is associated with the Pelican Lake Horizon and Besant Phase. Subsistence strategies are similar to the earlier phases of the Middle Archaic period, although bison hunting techniques appear to have become more elaborate. Though the Besant Phase is predominantly associated with high-mobility bison hunting on the Great Plains, the introduction of pottery into the region occurs at this time. This is a notable development given the association between the adoption of ceramics with more sedentary lifeways (MacDonald 2012).

The earliest archaeological components at the Head Smashed-In Bison Jump, in the foothills of the Rocky Mountains northwest of Cardston, Alberta, also date to the Plains Archaic period. The bison jump was first used some 6,000 years ago before being abandoned for more than 2,000 years (Brink 2008). The site was again used beginning in the Late Archaic, with at least three Pelican Lake occupations and a small Besant Phase occupation present at the site (MacDonald 2012). It is estimated that hundreds, and potentially thousands, of bison were killed at the site during this period. The Plains Archaic component of the site is also significant for evidence of an overlap between Pelican Lake and Besant occupations, suggesting that these projectile point styles may have been used contemporaneously by the same hunter-gatherer groups in the region or that different culturally distinct groups used the site in short succession (MacDonald 2012:115).

Another notable site in the region is the Kenney Site, a Besant site on the Oldman River in Alberta that is interpreted as an outlying camp associated with the Head Smashed-In Bison Jump. The site is notable for at least two Besant Phase occupations that yielded 59 projectile points and the remains of 20 bison, a deer, and a pronghorn. These remains were interpreted as representing evidence of secondary butchering and retooling (MacDonald 2012).

Late Prehistoric Period (ca. 1,500 to 300/200 BCE)

The transition from the Archaic Period to the Late Prehistoric Period is marked by the introduction of the bow and arrow, which is indicated by a significant reduction in projectile point size. The Late Prehistoric period is also associated with intensified use of ceramic technology in this region, suggestive of reduced mobility.

The first Late Prehistoric culture recognized in the area is the Avonlea Horizon. Diagnostic artifacts of this period include the Avonlea Triangular and Timber Ridge side-notched projectile points. Rather than acquiring higher-quality materials from sources such as Obsidian Cliff or the Knife River Flint quarries, lithic raw materials associated with these components are dominated by lower-quality cherts and quartzites procured locally (MacDonald 2012). Following this phase is the Old Women's Phase. This phase is identified by similar triangular and side-notched projectile point styles, including Plains side-notched types (Reeves 2003:63-64). In contrast with earlier Avonlea occupations, lithic raw materials associated with the Old Women's Phase include high-quality exotic materials that reflect trade with populations to the south (MacDonald 2012).

The most intensive use of the Head Smashed-In Buffalo Jump occurs during this Late Prehistoric period. This period is also associated with the use of the site by the Ancestral Blackfeet (MacDonald 2012). Deposits associated with the Avonlea occupation of the site include an extensive bonebed that is between 9 feet (2.7 meters) and 12 feet (3.7 meters) deep. Seasonality studies indicate that repeat bison kill events during the Avonlea Horizon occurred during the fall (MacDonald 2012).

The Old Women's Phase use of the site was the most extensive, extending over a 1,000-year period. At least two major occupation events have been identified during this period; however, the site was likely persistently reoccupied throughout this entire 1,000-year period (MacDonald 2012). The Old Women's Phase occupation of the site is notable for evidence of burning of the kill site, possibly to clear out the carcasses of bison from previous hunting episodes to maintain the buffalo jump for future use. As a result of these burning episodes, it is challenging to estimate the number of bison killed during this later period of use, but it is likely that it was in the upper hundreds or thousands.

D4.6.2 Contact and Post-Contact Period

During the Post-Contact Period (ca. 300/200 Common Era [CE] to present), the area was the home of Pikáni (including the Blackfeet, Blood, and Peigan). The traditional Pikáni winter camps were in the valleys of current Glacier National Park and the Waterton area of Canada. During the summers, they moved further onto the plains to follow bison herds. Other tribes from the west side of the mountains also seasonally used the plains, including the K'tunaxa, Coeur d'Alene, Salish, Upper Calispel, Colville, and Spokane (Reeves 2003:25-59).

Early Euro-American Exploration and Settlement

The earliest European visitors to Glacier County were likely fur trappers associated with the Hudson Bay Company or the Northwest Company in the eighteenth century. Peter Fidler, an employee of the Hudson Bay Company, surveyed the area beginning in 1792 and produced many of the early maps of Montana and Alberta (Robinson 1960; Beattie 1985). Fidler's maps contributed to Aaron Arrowsmith's (1802) map of interior North America, which is the first to depict

Chief Mountain (labeled as "The King") and the surrounding region. The Lewis and Clark expedition in 1805 is the first well-documented instance of Euro-Americans in the region. Camp Disappointment, a temporary camp occupied by part of the expedition July 22 through 26, 1806, was found along the Marias River, approximately 12 miles northeast of Browning. Small numbers of company-affiliated and independent fur trappers frequented the area into the 1840s; however, the area east of Glacier National Park was considered a "dead spot" that produced few furs (Robinson 1960). Permanent occupation of the area by Euro-Americans was relatively rare during this time and was largely limited to a succession of outposts (Fort Piegan and Fort McKenzie) built at the confluence of the Marias and Missouri Rivers (Robinson 1960).

The expeditions of the International Boundary Survey passed through the area in the 1860s and 1870s and were responsible for naming many of the landforms in the area. The Northwest Boundary Commission completed a boundary survey along the 49th parallel from the Pacific Ocean to the Continental Divide in 1861; however, it was not until 1872 that a survey of the 49th parallel was completed between the divide and Lake of the Woods, Minnesota (Robinson 1960). Rumors of gold led to prospectors encroaching on lands set aside for the Blackfeet in the Blackfoot and Gros Ventre Land Treaty of 1855, but no substantial gold discovery was ever made in this area (Ashby 1985).

This period was defined by conflict between Euro-Americans and Indigenous peoples in northwestern Montana, which culminated in the massacre of 200 Blackfeet people near present-day Shelby in 1870 (Wylie 2016). The Baker Massacre, named after the commanding officer of the U.S. Second Calvary, was committed against a band of Blackfeet suffering from a smallpox outbreak. The Blackfeet encampment that was attacked was part of Chief Heavy Runner's band, who were allies of the United States. The subsequent scandal in President Ulysses S. Grant's administration due to this episode led to the reversal of a plan to transfer the Indian Bureau to the jurisdiction of the War Department (Ashby 1985; Henderson 2018).

Transportation

The Glacier County area was rarely visited by Euro-Americans prior to improvements in the transportation network. Marias Pass along the south edge of the park became the focal point of transportation through the area. Although Lewis and Clark passed relatively near the park, the pass they used to cross the mountains was not conducive to rail traffic, and the railroad surveys of the 1850s attempted to find a better crossing for the proposed northern route. The government expedition came close to the pass but did not definitively identify it, and it was largely forgotten. Major George Ahern with an escort of the 25th cavalry (Buffalo Soldiers) looked for the pass during his explorations of the park and crossed the Continental Divide to the south of the Pass. Marias Pass finally became known to engineers of the Great North Railway when a Blackfeet guide led John F. Stevens to its location in 1889 (Athern 1931; Flandrau 1925).

The Great Northern Railway formed in 1889 out of the Minneapolis & St. Cloud Railroad Company, which merged with the St. Paul, Minneapolis & Manitoba Railway Company in 1890. Under the direction of James J. Hill, the railroad was built west through the Dakotas and into Montana, where the railroad crossed Marias Pass on the south edge of the future Glacier

National Park. The railroad reached its Pacific terminus at Scenic, Washington, in January 1893, completing its transcontinental route (Great Northern Railway 1951; Malone et al. 1991:80-81). The Glacier County area benefited from the Great Northern Railway in its early years as James Hill was interested in developing the region around his railroads to increase traffic. Hill invested a large sum of money in developing hotels, roads, backcountry chalets, and tour boats for Glacier National Park. The railroad was the main concessionaire for the park from 1910 until after the Second World War. During the war, the hotels and chalets in the park were closed. They reopened after the war, but many chalets were damaged due to lack of maintenance, and only two remained in use. Due to the rise of automobile traffic in the 1940s, the park concession became unprofitable, and the Great Northern Railway soon gave up its interest in the park (NPS 2015).

Blackfeet Indian Reservation

The Blackfeet Indian Reservation was first established by the Blackfoot and Gros Ventre Land Treaty of 1855 (Farr 2012). Included in this area were lands north of the Musselshell and Missouri Rivers, extending from the Rocky Mountains in the west to the confluence of the Missouri River and Milk River in the east. In 1871, however, the passage of the Indian Appropriations Act empowered the government to modify reservation lands through executive order (Farr 2012). Subsequent executive orders by President Ulysses S. Grant in 1873 and 1874 shrank the boundary of the Blackfeet Reservation to an area north of the Missouri River (Farr 2012). This occurred during a time of great peril for the Blackfeet, following the Baker Massacre, as smallpox and declining bison populations forced a reliance on meager government provisions (Farr 2012).

Amid critical food shortages, the Blackfeet left the reservation for hunting grounds in the Judith River basin in 1879 but were forcibly removed and confined to the reservation by the U.S. Army in 1880. What followed was a period of famine that culminated in the Blackfeet Starvation Winter of 1883 and 1884 (Farr 2012).

Renewed land negotiations in the years that followed were used to coerce the Blackfeet to make further concessions. These negotiations led to the Government Allotment Act of 1887, which constrained the Blackfeet Reservation by 17.5 million acres in exchange for annual payments to the tribe of $150,000 for 10 years (Ashby 1985). Although the reservation was still 1.76 million acres at this time, the Indian Appropriations Act of 1895 further reduced the reservation and ceded Blackfeet rights to the area that would later become Glacier National Park (Ashby 1985).

Milk River Project

The Milk River Project is an irrigation project that runs through Glacier and Hill Counties to serve farmland along a 165-mile stretch of the Milk River in Phillips, Blaine, and Valley Counties. The water for the project is collected in Lake Sherburne in Glacier National Park, discharged into Swiftcurrent Creek and eventually to the St. Mary River, and then diverted into the St. Mary Canal, which empties into the Milk River. The project was one of the earliest constructed by the Reclamation Service (predecessor of the Bureau of Reclamation), with initial plans prepared by the service only a few weeks after its creation in 1902, and was one of the first five projects approved by the Secretary of the Interior in 1903. Excavation on the canal began in 1907, although water rights and routing problems led to work being intermittent for several years and less than half the canal had been excavated by mid-1914. Work on the Lake Sherburne Dam began in 1914 but was not finished until 1921. As originally designed, the canal had a capacity of 850 cubic ft per second (cfs), although the siphons at St. Mary River and Hall's Coulee only had a capacity of 425 cfs because installation of the additional pipe siphons at those points were delayed until demand required their installation, which was completed in 1925. At the same time, additional work was conducted on many canal features that had originally been constructed of wood, which were rebuilt through the 1920s and 1930s, with Civilian Conservation Corps assistance after 1933 (Simonds 1998).

D4.6.3 File Search and Literature Review

HDR requested a file search from Montana SHPO of all previously recorded sites and previous surveys within .5 mile of the APE (Table D4-3 and Table D4-4). The file search identified 19 previously recorded sites in the APE, of which 3 are in the area being examined for the current study. The sites are the St. Mary Storage Unit (24GL155), a separately recorded historic bridge that is part of site 24GL155 (24GL164), and a precontact animal processing area (site 24GL1172 [formerly sites 24GL1172, 24GL1176, and 24GL1180]).

The file search also identified 35 previous surveys that overlap the APE, 13 of which overlap the current study area. The previous surveys cover 63 percent (759 acres) of the APE and 83 percent (112.5 acres) of the current study area.

In addition, the Blackfeet THPO provided GIS data point locations of previously identified artifacts and features found along the St. Mary Canal to assist in identifying unrecorded sites in the APE. The map showing the file search results is in Appendix A.

Table D4-3. Previously Recorded Cultural Resources Within .5 mile of the Project Area

Site No.	Resource Type	Resource Description	NRHP Eligibility from Previous Investigation
24GL0068[B]	Historic	Vehicular/Foot Bridge	Unevaluated
24GL0069[B]	Historic	Historic Site	Not Eligible (R)
24GL0081	Historic	Vehicular/Foot Bridge	Unevaluated
24GL0086	Historic	Vehicular/Foot Bridge	Unevaluated
24GL0088[B]	Historic	Vehicular/Foot Bridge	Unevaluated
24GL0155[A]	Historic	Irrigation System	Eligible (O)
24GL0162	Multicomponent	Precontact/Historic Site	Eligible (R)
24GL0163[B]	Historic	Vehicular/Foot Bridge	Eligible (O)

Site No.	Resource Type	Resource Description	NRHP Eligibility from Previous Investigation
24GL0164[A]	Historic	Vehicular/Foot Bridge	Eligible (O)
24GL0178[B]	Historic	Vehicular/Foot Bridge	Not Eligible (R)
24GL0179[B]	Historic	Vehicular/Foot Bridge	Not Eligible (R)
24GL0182	Historic	Historic Site	Eligible (R)
24GL0185	Historic	Log Structure	Not Eligible (R)
24GL0186	Historic	Vehicular/Foot Bridge	Eligible (O)
24GL0208	Historic	Stage Route	Unevaluated
24GL0209	Historic	Road	Unevaluated
24GL0384	Precontact	Stone Circle	Unevaluated
24GL0388	Precontact	Stone Circle	Unevaluated
24GL0405	Precontact	Stone Circle	Unevaluated
24GL0406	Precontact	Stone Circle	Unevaluated
24GL0416	Precontact	Stone Circle	Unevaluated
24GL0417	Precontact	Stone Circle	Unevaluated
24GL0418	Precontact	Stone Circle	Unevaluated
24GL0419	Historic	Historic Site	Unevaluated
24GL0460	Unknown	Bison remains	Unevaluated
24GL0846[B]	Historic	Road	Eligible (R)
24GL1089	Historic	Trash Dump	Not Eligible (R)
24GL1166[B]	Multicomponent	Precontact/Historic Site	Eligible (R)
24GL1167	Precontact	Animal Processing Area	Eligible (R)
24GL1168[B]	Precontact	Animal Processing Area	Eligible (R)
24GL1169[B]	Precontact	Lithic Material Concentration	Eligible (R)
24GL1170[B]	Precontact	Animal Processing Area	Eligible (R)
24GL1171[B]	Precontact	Animal Processing Area	Not Eligible (R)
24GL1172[A]	Precontact	Animal Processing Area	Eligible (R)
24GL1173[B]	Precontact	Animal Processing Area	Eligible (R)
24GL1174	Precontact	Animal Processing Area	Eligible (R)

Site No.	Resource Type	Resource Description	NRHP Eligibility from Previous Investigation
24GL1175	Precontact	Animal Processing Area	Eligible (R)
24GL1177[B]	Precontact	Rock Cairn(s)	Not Eligible (R)
24GL1178[B]	Precontact	Rock Cairn(s)	Not Eligible (R)
24GL1179[B]	Precontact	Animal Processing Area	Eligible (R)
24GL1181	Precontact	Vision Quest Structure	Eligible (R)
24GL1182	Multicomponent	Precontact/Historic site	Not Eligible (R)
24GL1183	Precontact	Animal Processing Area	Eligible (R)
24GL1224	Historic	Homestead/Farmstead	Not Eligible (R)

Note: A = In APE and Project area; B = In Project area (not in APE); O = Official; R = Recommended

Table D4-4. Previous Cultural Resource Surveys in .5 mile of Project Area

Report Number	Report Name	Report Date	Author(s)
FH 6 37963	*Glacier National Park FY11 Annual Cultural Resource Report*	5/18/2012	Johnson, Lon
GL 3 11151	*Blackfeet Housing Relocation*	5/21/1990	Keller, Marvin
GL 3 15468	*Konitz Contracting - Powell Gravel Source*	7/7/1993	Wood, Garvey C.
GL 3 20820[A]	*Cultural Resource Inventories Of Fifteen Proposed Cleanup Operations On The Blackfeet Reservation In Northwestern Montana*	6/1/1998	Nemeth, Catherine
GL 3 23207	*Northfork #2 Wildcat Oil Well*	9/23/2000	Wood, Garvey C.
GL 3 23208	*Northfork #3 Wildcat Oil Well*	9/23/2000	Wood, Garvey C.
GL 3 23209	*North Fork #4 Wildcat Oil Well*	9/23/2000	Wood, Garvey C.
GL 3 23210	*Northfork #4 Alternate Wildcat Oil Well*	9/23/2000	Wood, Garvey C.
GL 3 28456[A]	*Class I South Block And North Block, Allotee And Tribal Oil And Gas Mineral Leases On The Blackfeet Reservation In Glacier County, Montana*	4/15/2006	Wood, Garvey C.
GL 3 29839[B]	*Willow Creek #1 Oil Well And Access Road*	12/31/2007	Wood, Garvey C.
GL 3 30120[B]	*Babb Gravel Pit Expansion*	5/5/2008	Hall, Ramona
GL 3 32803[A]	*A Class III Cultural Resource Inventory of St. Mary Canal*	9/1/2008	Reeves, Brian

Report Number	Report Name	Report Date	Author(s)
GL 3 33090[B]	*A Cultural Resource Inventory For The Anschutz Exploration Corporation Proposed Pine Ridge 2-14-37-13 And 3-14h-37-13 Well Pads, Blackfeet Indian Reservation, Glacier County, Montana*	8/30/2011	Tyberg, Joel J.
GL 3 33108	*A Cultural Resource Survey For Newfield Production Company's Tribal Rumney 37-11-10-1h Oil Well And Access Road On The Blackfeet Indian Reservation In Glacier County, Montana*	10/1/2011	Nagra, Jenny
GL 3 33521[A]	*Class III Cultural Resource Inventory For The Proposed Anschutz Exploration. Mt 2011 2d Seismic Lines*	10/15/2011	HOPKINS, Seth and et al.
GL 3 3709	*A Class I Literature Review Of Chevron U.S.A., Inc. Lease Acreage On The Blackfeet Reservation, Montana*	5/1/1984	Senulis, John A.
GL 3 3750	*Babb Community Pump House And Drainfield*	10/31/1986	Wood, Garvey C.
GL 3 3756[B]	*Glacier Electric Cooperative, Inc. Blackfoot To Babb Transmission Line, Blackfoot Indian Reservation*	11/4/1987	Wood, Garvey C.
GL 4 23715	*U.S. 89 Browning-Hudson's Bay Divide And Duck Lake Road Archaeological And Cultural Investigations, Blackfeet Reservation, Glacier County Montana Vol. I And Vol. Ii*	3/15/2001	AABERG, Stephen A. and et al.
GL 4 28957[A]	*Cultural Resources Inventory St. Mary River -North Of Babb, Montana*	1/1/2006	Reeves, Brian
GL 4 37029[A]	*St. Mary- Spider Lake Road Mt 18(41) Control Number 6454*	3/1/2011	Platt, Steve
GL 4 3778[B]	*Survey Of St. Mary Canal Bridge East Of Babb (Br 9018(3)*	10/7/1985	Rossillon, Mitzi
GL 4 3782[B]	*An Archaeological Survey Of The St. Mary Canal Bridges*	11/1/1988	Rossillon, Mitzi
GL 4 3784[B]	*A Cultural Resources Inventory Of The St. Mary - Canadian Line Highway Project Area*	10/1/1989	Rossillon, Mitzi
GL 5 32979[A]	*Cultural Resource Inventory Of The Proposed Saint Mary Canal Drops Area Geotechnical Investigation*	8/1/2011	Rennie, Patrick J.
GL 6 11396[B]	*A Cultural Resources Inventory For Water And Power Facility Construction Near Camp Nine*	10/1/1990	Andrews, Michael J.
GL 6 11644[B]	*A Cultural Resource Inventory For Two Bridges Near Camp Nine, Glacier County, Montana*	11/1/1990	Andrews, Michael J.
GL 6 12721	*Fencing Project At Babb/Camp 9*	6/1/1991	Andrews, Michael J.
GL 6 13815[B]	*St. Mary Canal, Glacier County, Montana*	8/1/1992	Andrews, Michael J.
GL 6 15877	*Powell And Kennedy Creek Crossings, St Mary Canal*	6/1/1994	Andrews, Michael J.

Report Number	Report Name	Report Date	Author(s)
GL 6 15879[B]	*Drain Along St Mary Canal*	6/1/1994	Andrews, Michael J.
GL 6 16063	*Proposed Reroute For A Segment Of Aerial Powerline*	7/1/1994	Rennie, Patrick J.
GL 6 16147[A]	*Canal Segment Realignment Along The St. Mary Canal*	8/1/1994	Andrews, Michael J.
GL 6 16609	*Two Bridges Near Camp Nine - Addendum*	3/1/1991	Andrews, Michael J.
GL 6 16629[B]	*Cattle Guard Along St. Mary Canal*	9/1/1994	Andrews, Michael J.
GL 6 17338[A]	*Addendum To Cultural Resource Inventory For A Canal Segment Realignment Along The St. Mary Canal*	7/1/1995	Andrews, Michael J.
GL 6 18522[A]	*Cultural Resource Inventory: St Mary Siphon Repair Project, Glacier County, Montana*	10/1/1996	Andrews, Michael J.
GL 6 18523	*A Cultural Resource Inventory For A Drain/Turnout Along The St. Mary Canal, Glacier County, Montana*	11/1/1996	Andrews, Michael J.
GL 6 19436	*A Cultural Resource Inventory Of Two Slide Acres Along The St. Mary Canal, Glacier County, Montana*	11/1/1997	Andrews, Michael J.
GL 6 19439[B]	*A Cultural Resource Inventory Along The St. Mary Canal Near Martin Bridge, Glacier County, Montana*	11/1/1997	Andrews, Michael J.
GL 6 19440[A]	*Cultural Resources Inventory Along Kennedy Creek, Glacier County, Montana*	8/1/1997	Andrews, Michael J.
GL 6 19442	*A Cultural Resources Inventory For The Babb North Canal Realignment, St. Mary Canal, Glacier County, Montana*	11/1/1997	Andrews, Michael J.
GL 6 19455[B]	*A Cultural Resource Inventory For The Repair Of The St. Mary Canal Near Martin Bridge, Glacier County, Montana*	9/1/1997	Andrews, Michael J.
GL 6 19464	*A Cultural Resources Inventory For The Repair Of The St. Mary Canal Near Drop 1, Milk River Valley, Glacier County, Montana*	9/1/1997	Andrews, Michael J.
GL 6 19470[B]	*A Cultural Resources Inventory For Two Gauging Stations On The St. Mary Canal, Glacier County, Montana*	9/1/1997	Andrews, Michael J.
GL 6 20991[B]	*A Cultural Resources Inventory For A Canal Realignment Near Whitfords, St. Mary Canal, Glacier County, Montana*	9/1/1998	Andrews, Michael J.
GL 6 22256[A]	*Rehabilitation Of Drop Structures (Nos. 2,3 And 4) St. Mary's Canal, Glacier County, Montana*	7/1/1999	Andrews, Michael J.
GL 6 22630	*The Historic Cultural Resources Of The Milk River Project*	1/1/1991	Queen, Rolla

Report Number	Report Name	Report Date	Author(s)
GL 6 23868	*Proposed Test Drillings Along The St Mary River In Glacier County Montana*	8/1/2001	Vincent, William B.
GL 6 23923[B]	*Project Description Aquadam Installation And General Repairs At The St Mary Diversion Dam in Glacier County Montana*	9/1/2001	Vincent, William B.
GL 6 23924[B]	*A Cultural Resource Survey For A Canal Cleaning And Repair Project, St, Mary's Diversion Canal, Milk River Irrigation Project, Glacier County Montana*	9/4/2001	Carr, Hal D.
GL 6 24457[B]	*Notification Of Undertaking - Proposed Of Temporary Fish Nets At The St Mary Canal Headworks In Glacier County Montana*	1/1/2002	Vincent, William B.
GL 6 25181[B]	*Cultural Resources Inventory For The Proposed Installation Of A Buoy Line At The St Mary Diversion Dam And Canal Headworks In Glacier County Montana*	10/10/2002	Vincent, William B.
GL 6 27601[B]	*Notification Of Undertaking - Proposed Installation Of Canal Bank Cableway On The St. Mary Canal, Glacier County, Montana*	11/16/2004	Vincent, William B.
GL 6 37752[B]	*Browning Exchange Class I Survey Glacier County, Montana*	11/20/2014	Wendel, Ryan E.
GL 6 3794	*U.S. Postal Service - Babb Post Office 59411*	3/20/1988	Wood, Garvey C.
HL 6 30147	*Archaeological Survey Of The Wild Horse (Whm) Land Port Of Entry, Hill County, Montana*	11/1/2007	Ahlman, Todd M. and et al.
ZZ 6 16637	*Fiber Optic Line Port Of Piegan, Alberta To Thompson Falls; Construction Monitoring Report*	11/30/1994	Grant, David
ZZ 6 18787	*Montana-Canada Fiber Optic Line Glacier, Flathead, And Sanders Counties, Montana*	11/19/1993	Lewarch, Dennis E. and et al.

Notes: A = Overlaps APE and Project area; B = Overlaps Project area (not in APE)

D4.7 Survey Methods

Prior to the Class III pedestrian survey of the study area, HDR coordinated with the Blackfeet Nation THPO to identify known resources of interest to the Tribe that occur in or near the Project APE. The survey was conducted with a Tribal Cultural Specialist (TCS) to assist in identifying Tribally significant sites and materials in the survey. The survey was conducted on November 7 to November 8, 2023, by HDR archaeologists Lars Boyd and Paul Buckner and Blackfeet Tribal consultant Jay Bird. Lars Boyd and Paul Buckner meet the Secretary of the Interior professional qualification standards for archaeology.

Geospatial data was loaded onto GPS units prior to fieldwork to provide accuracy during the field review. All areas were inspected on foot in pedestrian transects of 15 meters or less. Transects were walked in a parallel pattern or were completed by walking parallel to canal embankments. Weather during the survey was overcast and cool, with temperatures ranging between 40- and 50-degrees Fahrenheit. Ground visibility was moderate (>50 percent) to high (>75 percent) throughout the APE, with improved visibility on ridges and hilltops and reduced visibility in drainages. When possible, erosion cutbanks, road cuts, and animal burrows were examined for indications of subsurface deposits. No artifacts or samples were collected. Digital photographs, field notes, GPS data, maps, and other data pertaining to the Project are housed at HDR's Englewood, Colorado, office.

Per Montana SHPO guidelines, a "site" is defined as a concentration of five or more prehistoric or historic artifacts with or without an associated feature. Some isolated features, such as rock art panels or stone circles, may also be recorded as sites. Cultural resources that do not meet these standards are recorded as isolated finds (MTSHPO 2022).

Eligibility recommendations for sites are based on NRHP criteria (NPS 1997). To warrant consideration for listing in the NRHP, a site must meet at least one of the four following criteria:

- The resource is associated with events that have made a significant contribution to the broad pattern of history.
- The resource is associated with lives of people significant in the past.
- The resource embodies distinctive characteristics of a type, period, or method of construction; represents the work of a master; possesses high artistic value; or represents a significant and distinguishable entity whose components may lack individual distinction.
- The resource has yielded, or may be likely to yield, information important in prehistory or history.

In addition to meeting at least one of the above criteria, a site must retain several, if not most, of the aspects of integrity, listed below. "Integrity" is defined as the authenticity of a property's historic identity, as shown by the survival of physical characteristics it possessed in the past and its capacity to convey information about a culture or people, historical patterns, or architectural or engineering design or technology.

- Location: The place where an event occurred or a property was constructed
- Design: Elements such as the plan, form, and style of a property
- Setting: The property's physical environment
- Materials: The physical elements used to construct the property
- Workmanship: The craftsmanship of the property's builders
- Feeling: The property's ability to convey a sense of historical time and place

- Association: The link between the property and a historic event, pattern of events, or person

D4.8 Inventory Results

The Class III cultural resources survey identified two previously recorded sites in the study area: the St. Mary Storage Unit of the Milk River Project (24GL155) and a precontact animal processing area (24GL1172). Additionally, two new sites were identified: a historic trash dump (24GL1786) and a precontact rock cairn (24GL1787). A map of the survey results is available in Appendix B, and site forms are available in Appendix C.

D4.8.1 Site 24GL155 – St. Mary Storage Unit of the Milk River Project

Site Type: Historic Irrigation System
Cultural Affiliation: Euro-American
NRHP Eligibility: Eligible (officially)

The St. Mary Storage Unit site consists of the canal and other associated portions of the water storage system. The first recording of the storage unit was conducted by BOR in 1989 but was mostly limited to historical information and included little description of the system's structures. Additional recordings have been limited to small areas or individual components of the system. These include a 1989 recording of a diversion dike along St. Mary River, the log coffer dam at Sherburne Lake in 2001, two short sections of the canal associated with oil well access road crossings in 2007 and 2009, and a reconnaissance survey of approximately 2 miles of the canal in 2011. To date, there has not been a comprehensive recording of the storage unit encompassing all the included components as suggested by BOR in 1989 (*Sherbourne Dam, Camp Nine, several construction camps, and concrete structures*) (Andrews 1989).

The current Project surveyed only a portion of the canal, focusing on features that are scheduled for repair or replacement. These consist of the Kennedy Creek Siphon, the Spider Lake Check Dam, Halls Coulee Wasteway, and Drop Structures 1, 3, and 4. Drop Structure 2 had previously suffered a failure, was replaced prior to the survey, and was not recorded in this update. In the following sections, the features are discussed as they occur on the St. Mary Canal from west to east.

Kennedy Creek Siphon

The Kennedy Creek Siphon is a concrete siphon that carries the canal under Kennedy Creek. The siphon is approximately 205 feet (63 meters) long. The openings are 25 feet wide (7.6 meters) with reinforced concrete wing walls 30 feet long that widen to 50 feet (15.25 meters) at the transition between the siphon and the canal. The openings on the east and west ends of the siphon are identical (Figure D4-7 and Figure D4-8).

Figure D4-7. Site 24GL155 Kennedy Creek Siphon, east side

Figure D4-8. Site 24GL155 Kennedy Creek Siphon, west side

Kennedy Creek Wasteway

The Kennedy Creek Wasteway is approximately 960 feet (292 meters) downstream from the Kennedy Creek Siphon. Wasteways exist in case a canal needs to be emptied during an emergency or for repairs. During the period of construction, the Reclamation Service used concrete extensively (Wilson 1909:240), and the Kennedy Creek Wasteway is an example of early Reclamation Service features of this type. The wasteway gate is 35 feet (10.7 meters) wide with three 9-foot-by-15-foot (2.7-meter-by-4.6 meter) chambers with manually operated wood and steel radial gates (Figure D4-9 and Figure D4-10). Poured concrete wingwalls 20 feet (6.1 meters) long widen to approximately 60 feet (18.3 meters).

Figure D4-9. Site 24GL155 Kennedy Creek Wasteway

Figure D4-10. Site 24GL155 Kennedy Creek Wasteway detail

Spider Lake Gate

The design of Spider Lake Gate is similar to the Kennedy Creek Wasteway gate and was used to control the flow from Spider Lake into the canal. The structure is approximately 40 feet long (12.2 meters) and 25 feet (7.6 meters) wide with three gate chambers, although the radial gates and associated equipment are no longer present (Figure D4-11). The reinforced concrete structure is damaged on the upstream side with portions of the internal rebar exposed (Figure D4-12).

Figure D4-11. Site 24GL155 Spider Lake Structure

Figure D4-12. Site 24GL155 Spider Lake Structure

St. Mary Siphon

The St. Mary Siphon was planned for a total capacity of 850 cfs to match the capacity of the canal. However, it was originally constructed from 1912 to 1915 with only one of the two steel conduits, with construction on the second conduit delayed until water demand on the canal required full capacity. The second conduit was added in 1925 to bring the siphon to full capacity (Figure D4-13). The siphon consists of two riveted steel 90-inch pipes that narrow to 84-inch sections at the crossing of St. Mary River before transitioning back to 90-inch pipe. The full length of the siphon is 3,255 feet (992 meters). The original (northern) siphon is buried for approximately half of its length, while the 1925 pipe is entirely aboveground. Both have regularly spaced concrete cradles along their lengths.

The crossing at St. Mary River is made over a 185-foot (56-meter) two span Pratt truss bridge with concrete piers and abutments. The bridge also supports an access road that parallels the siphon. The bridge was separately recorded in 1980 as 24GL164 but is lumped into this site because it was an original part of the siphon design.

Figure D4-13. Site 24GL155 St. Mary Siphon

Halls Coulee Siphon

The Halls Coulee Siphon is of similar construction to the St. Mary Siphon and was also constructed in two stages ca. 1912 and 1925. The siphon consists of two 90-inch (2.3-meter) riveted steel pipes. The full length of the siphon is 1,455 feet (443 meters). No bridge was required to cross the ephemeral drainage in Halls Coulee, and the pipes rest on concrete cradles. As with the St. Mary Siphon, the earlier (northern) siphon pipe is buried for much of its length, while the newer section is entirely aboveground (Figure D4-14).

Figure D4-14. Site 24GL155 Halls Coulee Siphon

Halls Coulee Wasteway

The structure of the Halls Coulee Wasteway is similar to the Kennedy Creek Wasteway. The concrete structure has three bays, and remnant ironwork in the bays show they originally mounted wood and steel radial gates (Figure D4-15). However, only one winch remains in place, and only parts of the iron portions of the gates remain. The feature is now closed by steel-reinforced board sliding gates, although no mechanism for raising the gates is in place. The gate incorporates a concrete drop structure to slow water flow from the canal during releases (Figure D4-16). The structure is approximately 25 feet (7.6 meters) wide at the canal. The full length of the feature is approximately 70 feet (21.3 meters), including the drop structure.

Figure D4-15. Site 24GL155 Halls Coulee Wasteway from canal

Figure D4-16. Site 24GL155 Halls Coulee Wasteway looking toward canal

Drop Structure 1

Drop structures are used to minimize erosion and reduce water speed where the canal has to descend a steep slope. The fall transfers water through an armored concrete chute to a stilling basin that dissipates the energy accumulated in the fall (Figure D4-17). The main body of the chute is approximately 30 feet (9.1 meters) wide, with the upstream wing walls reaching a maximum width of approximately 70 feet (21.3 meters). The downstream wing walls where the canal enters an artificial pond is approximately 40 feet (12.2 meters) wide. The length of the structure is approximately 200 feet (61 meters).

Figure D4-17. Site 24GL155 Drop Structure 1

Drop Structure 3

Drop Structure 3 is almost identical to Drop Structure 1 (Figure D4-18). The main body of the chute is approximately 30 feet (9.1 meters) wide, the upstream wing walls reach a maximum width of approximately 70 feet (21.3 meters), and the downstream wing walls are approximately 90 feet wide (27.4 meters), with a total length of approximately 200 feet (61 meters).

Figure D4-18. Site 24GL155 Drop Structure 3

Drop Structure 4

Drop Structure 4 is almost identical to Drop Structure 1 (Figure D4-19) but longer. The main body of the chute is approximately 30 feet (9.1 meters) wide, the upstream wing walls reach a maximum width of approximately 70 feet (21.3 meters), and the downstream wing walls are approximately 90 feet wide (27.4 meters), with a total length of approximately 330 feet (100.1 meters).

Figure D4-19. Site 24GL155 Drop Structure 4

NRHP Eligibility Recommendation

The St. Mary Storage Unit of the Milk River Project is officially eligible for inclusion in the NRHP under criteria A, B, and C. The canal was one of the first projects approved by the Reclamation Service and helped set the pattern for many other projects nationally. The project has been in service for more than a century and has contributed to the economic development of north-central Montana and communities just over the border in Canada.

The project serves eight irrigation districts under MRJBOC and in average years supplies 50 percent of the flow in Milk River, increasing to 90 percent during drought years. Although a minor use of water, municipalities including Chinook, Harlem, and Havre depend on canal flows for part of their municipal water supplies. The agricultural and civic development in the region would not have been possible without the project, making it significant under Criterion A.

The canal is also significant under Criterion B for its association with C.C. Babb, the engineer in charge of surveying the route for the project. Finally, the canal is significant under Criterion C as an example of irrigation projects constructed in the earliest years of the Reclamation Service; lessons learned during the construction were applied to later projects nationwide. The canal is not significant under Criterion D. Further study of the physical characteristics of the canal are unlikely to provide significant historical information not available in archival records relating to the construction of the canal.

The features of the canal listed in Table D4-5 are the main character-defining characteristics of the canal, requiring the most stringent design work. Although the current survey did not record the entirety of the canal, it did record the remaining constructed features of the storage system except for Sherburne Dam, which is approximately 5 miles west of the canal.

Table D4-5. Integrity of the Major Features of the Milk River Canal

Feature	Integrity	Supports Eligibility?
Kennedy Creek Siphon	The siphon is in good condition with no obvious modifications outside the period of significance. The feature retains integrity.	Yes
Kennedy Creek Wasteway	The wasteway is in good condition and retains its original wood and steel radial gates. The feature retains integrity.	Yes
Spider Lake Wasteway	The wasteway structure is deteriorated. The radial gates are no longer present, and the concrete is eroded. Integrity of materials and workmanship have been compromised.	No
St. Mary Siphon	The siphon is in good condition with no obvious modifications outside the period of significance. The feature retains integrity.	Yes
Halls Coulee Siphon	The siphon is in good condition with no obvious modifications outside the period of significance. The feature retains integrity.	Yes
Halls Coulee Wasteway	The wasteway structure is in overall good condition; however, the original radial gates were replaced at an unknown date, which has impacted integrity of materials and workmanship.	Yes
Drop Structures	All drop structures are in fair condition with no significant obvious modifications to their design.	Yes

Although there have been modifications to the canal that have impacted the integrity of some features, in aggregate the changes do not detract significantly from the integrity of the resource as a whole. The rural setting of the canal has preserved integrity of setting, feeling, and association. Although some features have deteriorated due to lack of maintenance, or in the case of Halls Coulee Wasteway, the original radial gates have been replaced by sliding gates, the changes are not sufficient to significantly impact integrity of design, materials, or workmanship for the resource as a whole. Integrity of location also remains intact.

D4.8.2 Site 24GL1172

Site Type: Precontact Animal Processing Area
Cultural Affiliation: Unknown Native American
NRHP Eligibility: Eligible

Site 24GL1172 is a precontact animal processing area that stretches along the southeastern bank of Spider Lake and down the Milk River Canal at an elevation of 4,445 feet (1,355 meters)

(Figure D4-20 and Figure D4-21). The sediments consist of fine-textured silty clay loam colluvium and alluvium. Sedimentation over millennia have filled the pre-existing basin of much larger glacial Spider Lake. Prior to the creation of the St. Mary Canal, Spider Lake was a larger lake or multiple shallow lakes between St. Mary River to west and Willow Creek to the east. The downcutting of Willow Creek breached the lake exit and permanently drained the shallow lake sometime in the Early Holocene/Late Pleistocene (Reeves 2008).

Figure D4-20. Site 24GL1172 overview facing northeast along Milk River Canal

Figure D4-21. Site 24GL1172 overview facing north along southeastern bank of Spider Lake

Site 24GL1172 was first recorded by Brian Reeves in 2007 for the St. Mary Canal cultural resource study as three separate sites: 24GL1172, 24GL1176, and 24GL1180 (Reeves 2008). All three sites were interpreted as Early Holocene/Late Pleistocene faunal processing sites composed of iron-stained faunal remains with associated lithic debitage, cores, or large processing tools (e.g., “choppers”). In addition, site 24GL1172, the largest site of the three, had fire-cracked rock and cobble features eroding from the southern wall of the canal (Figure D4-22). Most of the faunal remains were identified as bison with occasional horse bones. No artifact totals were given for any of the sites. However, the lithic material identified was argillite and quartzite.

Figure D4-22. Site 24GL1172 original site map showing its association with 24GL1176 and 24GL1180. Image Redacted.

Reeves' 2008 recording of the precontact components was limited to surface survey and observation. While the sites have been disturbed by the creation of the St. Mary Canal, Reeves determined the sites still had potential to yield intact, buried archaeological deposits consistent with the depositional environments represented by this landform. Reeves therefore recommended the sites as potentially eligible for the NRHP under Criterion D. Reeves also recommended that archaeological test excavations, geoarchaeological hand trenching, and backhoe test excavations be undertaken to further assess the site's research and interpretive value. These investigations would also serve to further understanding of the depth, age, cultural affiliations, and geological associations of the cultural deposits. Additionally, the subsurface testing program would aid in determining or verifying the boundaries of the sites and lead to the recovery of fire cracked rock, cultural features, and archeozoological remains not observed in his recording of the evidence on the surface of the sites.

HDR revisited sites 24GL1172 and 24GL1176 on November 7, 2023, and after a discussion with SHPO, it was agreed that 24GL1172, 24GL1176, and 24GL1180 should be combined under site 24GL1172 because all three sites were recorded as faunal processing sites, are in proximity of each other, and are on the same landform (Damon Murdo, personal communication, 2023). HDR's revisit of the site was limited to the extent of the APE, which was a 50-meter buffer around the existing dam structure. In the APE, HDR relocated 1 fire cracked rock concentration, 1 unifacially worked argillite tool, 1 argillite core, and 50 faunal elements. The site boundary was slightly expanded to encompass the cultural material and faunal remains identified during the revisit.

The fire cracked rock concentration, Feature 1 (F1), is on the southern bank of the St. Mary Canal. The concentration measures 6 meters north-south by 4 meters east-west and consists of approximately 50 pieces (Figure D4-23). Also in the concentration was one bison tooth and a fragment of the shaft of a mammal long bone. F1 has been repeatedly submerged during the periodic filling and draining of the canal, and it is impossible to determine whether this is the original location of the feature or if it eroded out of the canal wall.

Figure D4-23. Site 24GL1172 Feature 1 facing north

Two lithic artifacts were recorded in the APE. Field Specimen (FS) 1 is a unifacially worked argillite tool that may have been used to disarticulate the faunal remains that are now spread across the site. The tool measures 19 centimeters by 12.5 centimeters with a thickness of 4.6 centimeters and appears to have originated as a large primary flake that has been unifacially worked along the initial striking platform on the ventral surface of the flake. The edge of the tool was subsequently retouched several times, which reinforces the interpretation that this tool was used for animal processing (Figure D4-24).

FS2 is an argillite core that measures 10 centimeters by 9 centimeters with a thickness of 4 centimeters (Figure D4-25). Both artifacts were recorded along the southeastern bank of Spider Lake, which is subject to periodic filling and draining, which contributes to erosion of its banks, making it impossible to determine whether this is the original location of the feature or whether it has eroded out of the bank farther upslope.

Figure D4-24. Site 24GL1172 unifacially worked argillite tool

Figure D4-25. Site 24GL1172 argillite core

The 50 recorded faunal elements were distributed across the site surface in the APE. However, 36 remains were identified in a concentration along the southeastern bank of Spider Lake (Figure D4-26). The genera identified included bison and horse. In total, 35 of the faunal elements observed were complete or fragmented long bones or ribs that compared favorably to bison, horse, or other large mammal. One complete bison humerus was recorded on the southern bank of the canal, along with a partially buried scapula (Figure D4-27 and Figure D4-28). The remaining 15 faunal remains were teeth, 14 of which were from bison and 1 from a canine of unknown genera (Figure D4-29 and Figure D4-30).

The faunal remains were recorded on a surface that is subject to periodic filling and draining, which contributes to erosion of its banks, making it impossible to determine whether this is their original location or whether they eroded out of the sidewalls of the canal or the bank of the lake and have been transported downslope. While no faunal remains were observed in-situ eroding out of the sidewalls of the canal or the bank of Spider Lake, there are some areas of the site where cultural sediments are more than 3 meters deep (Figure D4-31). If these faunal remains did erode from the canal sidewall or the bank of the lake, there is potential for deeply stratified and ancient archaeological deposits.

Figure D4-26. Site 24GL1172 faunal remains concentration facing southwest

Figure D4-27. Site 24GL1172 bison humerus with iron staining

Figure D4-28. Site 24GL1172 scapula partially buried from canal sidewall collapse

Figure D4-29. Site 24GL1172 bison tooth partially buried along Spider Lake floor

Figure D4-30. Site 24GL1172 canine tooth on the floor of Spider Lake

Figure D4-31. Site 24GL1172 overview of canal wall showing the depth of sediments

NRHP Eligibility Recommendation

Site 24GL1172 was previously recommended as potentially eligible for the NRHP under Criterion D for its potential to yield intact, buried archaeological deposits dating back to the Early Holocene/Late Pleistocene. HDR agrees with the previous recommendation. The revisit to only a fraction of the site identified faunal remains in association with a lithic tool possibly used for animal processing in deposits dating to the Early Holocene/Late Pleistocene.

D4.8.3 Site 24GL1786

Site Type: Historic Trash Dump
Cultural Affiliation: Euro-American
NRHP Eligibility: Not Eligible

Site 24GL1786 is a newly recorded historic trash dump. The site extends over 0.2 acre (773 square meters) on the northwest slope of a ridge above the St. Mary River. It is in a foothill grassland ecological setting at an elevation of 4,327 feet, with vegetation consisting of foothill prairie grasses, dense patches of montane shrubs, and low-lying forbs (Figure D4-32). Ground visibility is low (25 to 50 percent) throughout the site. Surficial sediments consist of brown silt loam in a residual and colluvial depositional environment. The nearest perennial water source is the St. Mary River, 0.15 mile (0.2 kilometer) to the north. Site 24GL1786 has a northwest-facing aspect with a viewshed of the St. Mary River valley. The St. Mary Siphon passes 130 feet (40 meters) to the west.

Figure D4-32. Site 24GL1786, site overview, facing south

Site 24GL1786 consists of two historical features. F1 is a wood and corrugated metal platform, likely a flatbed construction trailer (Figure D4-33). The feature is constructed from a frame of dimensional wooden planks and corrugated sheet metal. The frame is fastened with wire nails, and the corrugated sheet metal forms the bed of the trailer. The feature is 12.5 feet long, 7.75 feet wide, and 1.66 feet high. No preserved tires, wheels, or axels are associated with F1.

F2 consists of a broken structural arch produced from poured concrete, possibly a displaced pipe support for the nearby St. Mary Siphon (Figure D4-34). The concrete archway has broken into three large slabs, each approximately 1.3 feet thick and 3 to 5 feet in maximum dimension. The concrete contains copious amounts of stone aggregate, mostly large pebbles with lesser amounts of small cobbles. No rebar reinforcement is apparent in the concrete. A segment of wire rope cable is wrapped around the feature. The concrete feature is visible in historical aerial imagery, including the earliest available image of the area from 1959 (U.S. Geological Survey 1959).

Collectively, the pre-1959 date associated with F2 and the wire nails used in the construction of F1 indicate the site dates between ca. 1900 and 1959 (Wells 1998). These features may represent discarded equipment and materials associated with the construction or maintenance of the St. Mary Canal; however, this association cannot be conclusively demonstrated.

Figure D4-33. Site 24GL1786, detail of Feature 1, facing south

Figure D4-34. Site 24GL1786, detail of Feature 2, facing east

NRHP Eligibility Recommendation

HDR recorded site 24GL1786 as a historic trash dump consisting of a flatbed construction trailer and a poured concrete arch support. The site is not associated with historically significant events, so HDR recommends site 24GL1786 as not eligible for inclusion in the NRHP under Criterion A. The site is similarly not associated with historically significant persons, so HDR recommends the site as not eligible for inclusion in the NRHP under Criterion B. The site lacks unique elements of design or construction, so HDR recommends site 24GL1786 as not eligible for inclusion in the NRHP under Criterion C. Finally, the site represents an ephemeral historical construction dump with few associated artifacts, and no indication of a subsurface component.

D4.8.4 Site 24GL1787

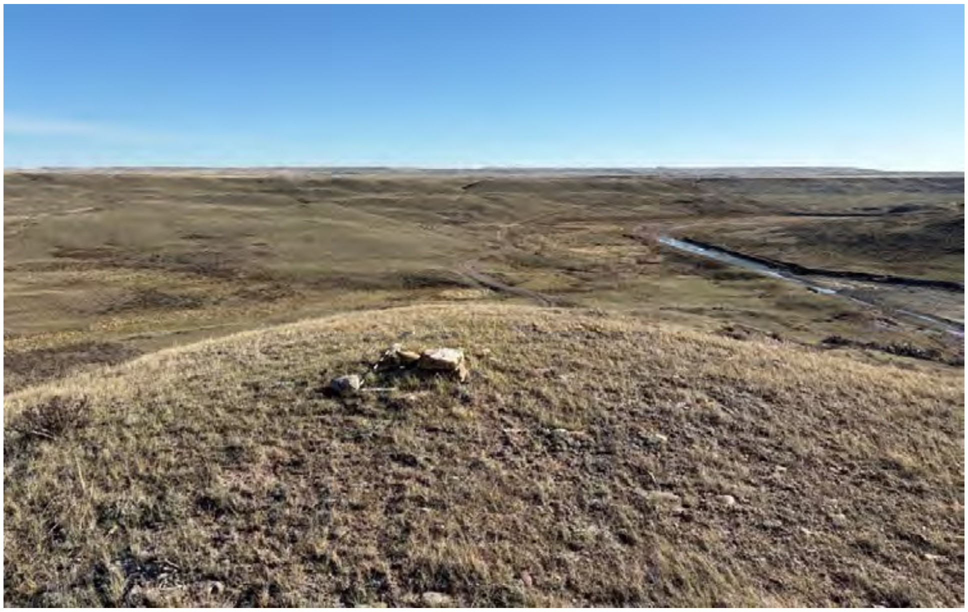
Site Type: Precontact Rock Cairn
Cultural Affiliation: Unknown Native American
NRHP Eligibility: Unevaluated

Site 24GL1787 is a rock cairn with a probable precontact age and Native American affiliation. HDR's recording is the first formal documentation of site 24GL1787; however, the approximate location of the cairn was marked in Blackfeet THPO records with a notation stating it was "originally listed as grave at BOR." The referenced BOR documentation could not be identified during the file search and literature review for the Project, and no additional information is available to support its interpretation as a grave.

The site extends over 0.006 acre (25 square meters) on a gently sloped hilltop at an elevation of 4,320 feet. It is in a foothill grassland ecological setting with vegetation consisting of diffuse foothill prairie grasses and low-lying forbs (Figure D4-35). Ground visibility is high (>75 percent) throughout the site. The hilltop has been deflated by wind erosion, leaving a lag deposit of gravels and cobbles underlain by Willow Creek formation bedrock. Surficial sediments are shallow and discontinuous and consist of brown silt loam in a residual depositional environment.

The nearest perennial water source is the North Fork of the Milk River, 0.8 mile (1.3 kilometer) to the southeast. Site 24GL1787 has an open aspect with a prominent viewshed to the east and west that includes Dubray Coulee, the North Fork of the Milk River valley, and Sofa Mountain and the Rocky Mountain Front. The international border is 0.7 mile (1.1 kilometers) to the north of the site, while diverging spurs of the St. Mary Canal Road pass 75 meters to the north and 5 meters to the south. The St. Mary Canal is 50 meters south of site 24GL1787.

Figure D4-35. Site 24GL1787, site overview, facing east



F1 is a piled cairn that is 270 centimeters long, 190 centimeters wide, and 26 centimeters high (Figure D4-36). The cairn was constructed from approximately 29 cobbles of locally occurring granite. Cairns are among the most ubiquitous features in the northwestern plains and were used by both precontact and historical peoples for a range of functions. Mobile hunter-gatherers in Montana and Alberta often used cairns to define trails, form drivelines, mark caches or locations for later reoccupation and for the social construction of landscape (Amundsen-Meyer and Leyden 2020). Ethnographic data suggests that the Blackfeet may have used isolated hilltop cairns to mark observation posts (Amundsen-Meyer and Leyden 2020:176).

In the absence of associated artifacts, lichen cross-bridging or siltation provide a rough indication of approximate age for these features. No evidence of lichen cross-bridging is apparent on F1; however, the feature is heavily silted, which indicates the cairn has remained undisturbed for an extended period and may be of precontact age (Dooley 2004). The piled construction and hilltop position of F1 is consistent with examples of precontact cairns elsewhere in the northwestern plains, suggesting a likely precontact temporal affiliation (Amundsen-Meyer and Leyden 2020).

While historical cairns can be difficult to distinguish from precontact features in form, they are typically associated with other historical landscape features such as stock grazing grounds, property boundaries, mining claims, survey markers, trails, or roads. Though site 24GL1787 is positioned near the St. Mary Canal and St. Mary Canal Road, it does not clearly delineate these historical features, and similar cairns are not found elsewhere along the path of either the canal or road.

Figure D4-36. Site 24GL1787, detail of Feature 1, facing south

NRHP Eligibility Recommendation

HDR recorded site 24GL1787 as a rock cairn with a probable precontact affiliation. Tribal consultation is necessary to evaluate the significance of the site under Criterion A, and HDR recommends site 24GL1787 as unevaluated for inclusion in the NRHP under this criterion. The site is not associated with significant historical persons, so HDR recommends the site as not eligible for inclusion in the NRHP under Criterion B. The site similarly lacks unique elements of design or construction and does not embody distinctive characteristics of precontact cairns, so HDR recommends site 24GL1787 as not eligible for inclusion in the NRHP under Criterion C. Finally, the site lacks an associated artifact assemblage, and sediments are shallow with a low probability of an intact subsurface cultural component. The surface of the site consists of a densely compacted lag deposit of gravels and cobbles, making it unlikely that the cairn represents a burial. Though this cannot be conclusively established without excavation, piled cairns are common features in this region and have many functions that are more common than their use as burial markers (Amundsen-Meyer and Leyden 2020). Therefore, in the absence of additional data supporting the interpretation of the cairn as a burial marker, the site's data potential has been exhausted by this recording, and HDR recommends the site not eligible for inclusion in the NRHP under Criterion D.

D4.9 Project Effects and Management Recommendations

The survey identified four cultural resources in the area examined for the current study. These include the previously documented St. Mary Canal (24GL155) and a precontact animal processing area (24GL1172). Site 24GL1172 was originally recorded by Reeves (2008) as three separate sites (24GL1172, 24GL1176, and 24GL1180); however, HDR coordinated with the Montana SHPO to combine these localities into a single site given their proximity. The remaining cultural resources are newly recorded and comprise a historic trash dump (24GL1786) and a precontact rock cairn (24GL1787). The Project has the potential to impact these resources, with the nature of the impact depending on the Project alternative chosen. Three alternatives have been proposed for the Project:

- **Alternative 1 – No Action**. Under this alternative, no work will be conducted to modernize the canal, and it will be left in its current condition.
- **Alternative 2 – Canal Modernization, Line/Reshape**. Under this alternative, the nine features described in the Inventory Results section will be replaced along with other smaller components of the system, the canal itself will be recontoured to improve the existing canal cross-section and re-establish minimum freeboard, and the canal will be lined with a geosynthetic lining to improve water retention.
- **Alternative 3 – Canal Modernization, Reshape**. This alternative is identical to Alternative 2 except that the geosynthetic lining of the canal will be omitted.

D4.9.1 Project Effects

This section addresses the potential impacts on the four sites recorded by the survey. The potential impact of each alternative is discussed with recommended management practices.

Site 24GL155 – St. Mary Storage Unit

Site 24GL155 is officially eligible for inclusion in the NRHP under criteria A, B, and C. Under Alternative 1, no improvements to the canal will be made, the existing features of the canal will remain unchanged, and there will be no impacts on site integrity or eligibility.

Under Alternative 2, the Kennedy Creek Siphon will be replaced with a new concrete structure; the St. Mary River Siphon and the Halls Coulee Siphon will be left in place with new siphon structures built paralleling the existing structures; the Kennedy Creek Wasteway, Halls Coulee Wasteway, and the Spider Lake Check Dam will be replaced with new structures; Drop Structures 1, 3, and 4 will be abandoned in place, and new paralleling drop structures will be constructed; and the geometry of the existing canal alignment will be modified and a geosynthetic lining installed.

Alternative 3 differs from Alternative 2 only in not installing the geosynthetic lining. Both Alternatives 2 and 3 will have significant impacts on the site. The reconstruction of wasteways, the check dam, and the Kennedy Creek Siphon will impact integrity of design, materials, and workmanship for the storage unit, while the abandonment and construction of new structures for the St. Mary and Halls Coulee Siphons and the Drop Structures will be a visual intrusion on the site, impacting integrity of setting and feeling.

Site 24GL1172

Site 24GL1172 is a precontact animal processing site exposed in the sides of the canal that is officially eligible for inclusion in the NRHP under Criterion D. Under Alternative 1, no construction will occur, and the site will not be affected by the Project. Under Alternatives 2 and 3, site deposits will be impacted by construction of the gate structure and recontouring of the canal profile. This has the potential to impact parts of the site containing significant data on precontact use of the area (aspects of integrity design and association).

Site 24GL1786

Site 24GL1786 is a historic dump consisting of the remnants of a trailer and concrete fragments that may be a failed support for the nearby St. Mary Siphon. The site is recommended not eligible for inclusion in the NRHP under any criterion. Although in the project APE, the site is not in the area of direct impacts from the Project. Because the site is not a historic property, there would be no adverse effect if it is impacted by construction.

Site 24GL1787

Site 24GL1787 is a cairn on a small knoll that overlooks the St. Mary Canal. The cairn appears to be of precontact age and was noted in a .kmz file provided by Blackfeet THPO as “originally listed as grave at BOR.” Because its identification as a grave is uncertain, it is left unevaluated pending further Tribal consultation. Pending consultation, HDR recommends that the site be managed as if it is an eligible historic property.

The cairn is in the APE but on a knoll that is approximately 7 meters from an O&M road that will be upgraded as part of the Project. Given its position, it is unlikely that the cairn will be directly impacted by the Project.

D4.9.2 Management Recommendations

Three project alternatives were identified in the draft Environmental Impact Statement (EIS) for the Project. Under Alternative 1, there will be no adverse effects on historic properties, and no further work is warranted. Under Alternatives 2 and 3, there will be an adverse effect on sites 24GL155 and 24GL1172. Site 24GL1786 is recommended as not eligible for inclusion in the NRHP and does not constitute a historic property. Site 24GL1787 is an unevaluated precontact cairn in the APE but will not be directly affected by the project.

Under Alternative 1, no work will occur, and no further work on the Project is recommended. Alternatives 2 and 3 will impact portions of the canal that were not surveyed by the current survey. If Alternative 2 or 3 is chosen, HDR and NRCS will develop a memorandum of agreement (MOA) and treatment plan to address the mitigation of Project impacts on sites 24GL155 and 24GL1172. The MOA will recommend additional Class III cultural resource surveys to identify and document cultural resources in the remainder of the APE. Historic properties identified by the additional survey will be evaluated and treated according to standard Section 106 regulations. The MOA will further recommend mitigation and treatment measures to resolve adverse effects on sites 24GL155 and 24GL1172. These measures could potentially include supplemental archaeological documentation for site 24GL1172, a Historical American Engineering Record recording of the St. Mary Storage Unit (24GL155), and the completion of an NRHP Registration Form 10-900 and accompanying forms, as appropriate, for the St. Mary Storage Unit (42GL155).

D4.10 Summary

HDR completed a Class III cultural resource survey of a portion of the Project APE to assist MRJBOC, NRCS, and BOR in complying with their responsibilities under Section 106 of the NHPA. The proposed Project constitutes an undertaking as defined in the implementing regulations of the NHPA at 36 CFR 800. The NHPA requires federal agencies to consider the potential effects of an undertaking on "historic properties," which are defined as cultural resources that are listed in, or eligible for inclusion in, the NRHP. As part of this process, the lead federal agency must identify cultural resources in the APE, evaluate the eligibility of these resources for inclusion in the NRHP, and assess potential adverse effects on historic properties. If adverse effects are likely to occur on a historic property, the lead agency must consult with SHPO and THPO and identified consulting parties to consider means to minimize, avoid, or mitigate these effects. While MRJBOC is the Project proponent, NRCS is serving as the lead federal agency and BOR as a cooperating agency.

NRCS has determined that environmental impacts from the Project are likely to be significant and has accordingly published a NOI to prepare a Watershed Plan-EIS. The Plan-EIS would assess and disclose the potential effects of the Project and would investigate alternatives to modernize the existing St. Mary Canal and associated infrastructure. The Plan-EIS is required to request federal funding through the Watershed Protection and Flood Prevention Act (P.L. 83-566). The three alternatives in the Plan-EIS are Alternative 1 – No Action, Alternative 2 – Canal Modernization and Line/Reshape, and Alternative 3 – Canal Modernization and Reshape. The APE for the EIS is larger than the area surveyed for this report and includes the length of the canal from the St. Mary River to Milk River. NRCS has determined that the archaeological investigations for the Project will follow a phased approach, and the initial survey in this report focuses on areas common to Alternatives 2 and 3 where repair and/or replacement of existing features will take place.

HDR completed the Class III cultural resource survey of a portion of the Project APE in November 2023. The survey covered 136 acres across 9 discontinuous survey locations, which include the Kennedy Creek Siphon, the St. Mary River Siphon, the Halls Coulee Siphon, the Kennedy Creek Wasteway, Spider Lake Check Dam, the Halls Coulee Wasteway, and Drops 1, 3, and 4. The entirety of the Project APE is in the Blackfeet Indian Reservation, and HDR archaeologists were accompanied by a representative of the Blackfeet Nation THPO to provide Project oversight and support. The survey identified four cultural resources in the portion of the APE examined for this study. These include the previously documented St. Mary Canal (24GL155) and a precontact animal processing area (24GL1172). Site 24GL1172 was originally recorded by Reeves (2008) as three separate sites (24GL1172, 24GL1176, and 24GL1180); however, HDR coordinated with the Montana SHPO to combine these localities into a single site given their proximity. The remaining cultural resources are newly recorded and comprise a historic trash dump (24GL1786) and a precontact rock cairn (24GL1787).

All resources were evaluated for their eligibility for inclusion in the NRHP. The St. Mary Canal (24GL155) is officially eligible for inclusion in the NRHP, and no additional information was noted to warrant reconsideration of its eligibility status. Site 24GL1172 was previously recommended eligible for listing in the NRHP under Criterion D, and HDR agrees with this previous recommendation. HDR recommends site 24GL1786 as not eligible for inclusion in the NRHP under any criteria, and no further work is recommended. Per Montana SHPO guidelines, HDR recommends site 24GL1787 as unevaluated for listing in the NRHP pending Tribal consultation on its significance under Criterion A. Pending clarification, site 24GL1787 should be managed as eligible and avoided by Project impacts.

Based on the criteria for what constitutes adverse effects contained in 36 CFR 800.5, the proposed Project will have an adverse effect on the St. Mary Canal (24GL155) and its associated infrastructure. As currently designed, the Project is also likely to have an adverse effect on buried archaeological deposits associated with site 24GL1172. Following concurrence with this effects recommendation, HDR advises the development of a MOA, per 36 CFR 800.5, to resolve these adverse effects.

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Appendix A: Map of Previous Sites and Surveys

Appendix A contains Controlled Unclassified Information [CUI])

Appendix B: Survey Results

(Appendix B contains Controlled Unclassified Information [CUI])

Information Redacted

Appendix C: Site Forms

Appendix C contains Controlled Unclassified Information [CUI])

Information Redacted

PROGRAMMATIC AGREEMENT
AMONG THE
U.S. DEPARTMENT OF AGRICULTURE,
NATURAL RESOURCES CONSERVATION SERVICE, MONTANA STATE OFFICE,
THE BLACKFEET TRIBAL HISTORIC PRESERVATION OFFICER,
THE BUREAU OF RECLAMATION, MONTANA AREA OFFICE,
AND THE MILK RIVER JOINT BOARD OF CONTROL
REGARDING PHASED IDENTIFICATION AND EVALUATION
OF HISTORIC PROPERTIES FOR THE
MILK RIVER AND SAINT MARY WATERSHEDS,
GLACIER COUNTY, MONTANA

WHEREAS, the United States Department of Agriculture Natural Resources Conservation Service (NRCS) administers numerous voluntary assistance programs, special initiatives, and grant and emergency response programs for soil, water, and related resource conservation activities available to eligible private producers, States, commonwealths, Federally Recognized Tribal governments, other government entities, and other applicants for conservation assistance, pursuant to the Agricultural Act of 2018 (2018 Farm Bill, Public Law 113-79); the Flood Control Act of 1944 (Public Law 78-534, as amended); the Watershed Protection and Flood Prevention Act (Public Law 83-566, as amended, 16 U.S.C. 1001-1012); the Flood Control Act of 1936 (Public Law 74-738); and executive and secretarial orders, implementing regulations and related authorities; and

WHEREAS, Natural Resources Conservation Service Montana State Office (NRCS), through the Watershed Protection and Flood Prevention program, as authorized by the Watershed Protection and Flood Prevention Act (Public Law 83-566, as amended, 16 U.S.C. 1001-1012), is providing assistance to the Milk River Joint Board of Control (MRJBOC) to develop a project, including a Watershed Plan-Environmental Impact Statement to assess the 29-mile Saint Mary Canal and its associated facilities, and to consider alternatives to increase irrigation water supply reliability for water users and reduce hazards associated with conveyance system failure; and

WHEREAS, NRCS has determined that the proposed project is an undertaking, as defined by the National Historic Preservation Act of 1966 as amended (NHPA; 54 U.S.C. § 300320) and 36 CFR § 800.16(y), and is referred to hereinafter as the Undertaking; and

WHEREAS, the U.S. Bureau of Reclamation, Montana Area Office (Reclamation) is the Federal Agency that owns and operates the Saint Mary Canal and associated lands, and has roles and responsibilities under this agreement as a Cooperating Federal Agency; and Reclamation has designated NRCS as the lead Federal Agency for this Undertaking to fulfill compliance requirements as set forth in the NHPA and the Natural Environmental Policy Act of 1969 (NEPA, 43 U.S.C. § 1638) and 7 CFR § 1(b); and

WHEREAS, NRCS has determined that the Undertaking has the potential to cause effects to historic properties (36 CFR § 800.3(a)) and, therefore, is subject to Section 106 of the NHPA, 54 U.S.C. § 306108, referred to hereinafter as Section 106; and

WHEREAS, NRCS has determined that selection of action Alternatives associated with the Undertaking have multiple phases including: 1) canal reshaping and possible lining; 2) siphon replacement; 3) drop structure replacement; 4) access road improvements; 5) improvements to wasteway turnouts; 6) underdrain replacement; and 7) landslide mitigation (Appendix A); and

WHEREAS, NRCS cannot fully anticipate or determine the effects of the Undertaking to historic properties because design work for the Undertaking is estimated to be at less than 10% complete and may include additional construction extents, material sources, staging areas, and laydown yards that are currently undefined; and

WHEREAS, the Saint Mary Canal and archaeological site 24GL1172 have been determined eligible for the National Register of Historic Places (NRHP) but potential effects to them have not been fully identified and evaluated; and

WHEREAS, NRCS proposes phased identification and evaluation of historic properties in accordance with 36 CFR § 800.4(b)(2), and phased application of the criteria in accordance with 36 CFR § 800.5(a)(3) and, if applicable, the resolution of adverse effects in accordance with 36 CFR § 800.6.; and

WHEREAS, NRCS, with the concurrence of Required and Invited signatories, proposes to comply with the Section 106 process for the Undertaking through the execution and implementation of this Agreement, per 36 CFR § 800.14(b)(1)(ii), before the Undertaking will be approved and funded; and

WHEREAS, Required and Invited signatories, as well as concurring parties will hereinafter be referred to as Signatories; and Signatories and other consulting parties as outlined in 36 CFR § 800.2(C), will be hereinafter referred to as Consulting Parties; and

WHEREAS, in accordance with 36 CFR § 800.2(c)(2)(i)(A) the Blackfeet Tribal Historic Preservation Officer (THPO) has assumed the responsibilities of the Montana State Historic Preservation Officer (SHPO) for Section 106 on the Blackfeet Reservation, and NRCS has invited the THPO to participate as a Required Signatory in the development of this Programmatic Agreement (hereinafter referred to as the Agreement) and they have accepted in a letter dated November 21, 2025; and

WHEREAS, Reclamation is a Cooperating Federal Agency as the administrator of the Saint Mary Canal, and therefore is an Invited Signatory to this Agreement; and

WHEREAS, MRJBOC is the non-Federal sponsor for the Undertaking and the MRJBOC has roles and responsibilities under this Agreement and therefore is an Invited Signatory to this Agreement; and

WHEREAS, MRJBOC is responsible for the design, engineering, and construction of the Undertaking and will coordinate with NRCS and Reclamation to facilitate and fund the completion of any needed historic property inventory survey. MRJBOC will also coordinate with NRCS and Reclamation to facilitate and fund any measures required for mitigation of adverse effects to historic properties as determined by NRCS and Reclamation; and

WHEREAS, in accordance with 36 CFR § 800.2(c)(2)(ii)(A), 800.3(f)(2), and 800.14(b)(2)(i), NRCS has consulted with the Blackfeet Nation of the Blackfeet Indian Reservation of Montana and invited them to consult on this Undertaking and to participate as a concurring party to this Agreement given that all proposed Undertaking activities will be constructed on lands located entirely within the boundaries of the Blackfeet Indian Reservation; and

WHEREAS, activities for this Undertaking will be constructed on tribal Trust lands administered by the Bureau of Indian Affairs, Rocky Mountain Regional Office (BIA), and the BIA has been invited to consult on this Undertaking and to participate as a concurring party to this Agreement; and

WHEREAS, activities for this Undertaking will require permitting from the U.S. Army Corps of Engineers, Omaha District (USACE), and USACE has been invited to consult on this Undertaking and to participate as a concurring party to this Agreement; and

WHEREAS, in accordance with 36 CFR § 800.6(a)(1), NRCS has notified the Advisory Council on Historic Preservation (ACHP) of its phased approach to the Section 106 process and the potential for adverse effect determinations, and the ACHP has chosen not to participate in the consultation at this time in correspondence dated August 18, 2025 and August 25, 2025; and

WHEREAS, unless otherwise noted, all timelines within this Agreement are in calendar days; and

WHEREAS, in accordance with 36 CFR § 800.6(a)(4) and 36 CFR § 800.14(b)(2)(ii), NRCS has notified the public of the Undertaking and provided an opportunity for members of the public to comment on the Undertaking and the Section 106 process as outlined in this Agreement; and

NOW, THEREFORE, the Signatories agree that this Undertaking shall be implemented in accordance with the following stipulations to take into account the effect of the Undertaking on historic properties.

STIPULATIONS

NRCS shall ensure that the following stipulations are met and carried out:

1 Conditions

- As the Federal agency, NRCS will administer this Agreement.

- NRCS shall ensure that the terms of this Agreement are met and implemented prior to issuing a State Conservationist signed Notice to Proceed for construction for any phase of the Undertaking. NRCS may issue the Notice to Proceed for a phase of the Undertaking while the implementation and meeting of terms on other construction phases remain on-going. NRCS will not issue the Notice to Proceed for a phase until after Stipulations IV-VI have been completed for that phase. NRCS will ensure that MRJBOC has obtained all required permits and/or permissions prior to issuing the Notice for any phase of the undertaking.

- In the event that another federal agency not initially a party to or subject to this PA receives an application for funding/license/permit for the Undertaking as described in this PA, that agency may fulfill its Section 106 responsibilities by stating in writing it concurs with the terms of this PA and notifying NRCS, Blackfeet THPO, and the ACHP that it intends to do so. Such agreement shall be evidenced by implementation of the terms of this PA and attachments.

2 Professional Qualification Standards

- All technical work required for historic preservation activities implemented pursuant to this Agreement shall be carried out by or under the direct supervision of a person or persons meeting, at a minimum, the *Secretary of Interior's Professional Qualifications Standards* in the appropriate discipline (36 CFR § 61, Appendix A). Persons meeting these qualifications are typically known as "Secretary of Interior (SOI) qualified". "Technical work" is defined as all efforts to inventory, evaluate, and perform subsequent treatment such as data recovery, excavation, or recordation of potential historic properties that is required under this Agreement.

- NRCS acknowledges that the Blackfeet Nation holds cultural, historical, and reserved treaty rights within the affected area and has special expertise in evaluating the eligibility of historic properties that may possess religious and cultural significance for them (36 CFR § 800.4(c)(1)). Blackfeet Tribal representatives who may comment on or participate in the identification and evaluation of historic properties of religious and cultural significance to a tribe will be determined by the Blackfeet Nation and consulted by NRCS.

- All ground-disturbing activities within the construction footprint and extents will be monitored by Blackfeet Tribal Cultural Specialists (TCS) that will be coordinated through the Blackfeet THPO. These activities include excavation, trenching, blading, grading, vegetation clearing, borrow pit development, and road/canal modernization.

3 Defining the Area of Potential Effects (APE)

- The APE, as demarcated in Appendix A, encompasses the Undertaking as currently defined. As the plans and designs for the Undertaking are further developed and finalized, or once an alternative is selected, NRCS may modify the APE for the Undertaking to include all geographic areas that may be directly or indirectly affected.

- Once established, NRCS will submit the modified APE to all Consulting Parties for review prior to completing historic property inventories. Upon receipt, all parties will have 30 days to review and provide comments on the modified APE.

- NRCS will take into account any comments on the APE and finalize the APE based on comments received. Failure of any party to comment within 30 days shall not preclude NRCS from finalizing the modified APE.

- After the comment period, NRCS is responsible for distributing the final APE to all parties to the Agreement. NRCS will also update Appendix A of this Agreement with the final APE.

4 Phased Identification and Evaluation

I. Work within the APE has been divided into several components that will be inventoried and evaluated in phases. Each phase will follow the process described in Stipulations IV, V, and VI and may occur concurrently. As inventory efforts within the APE may be nonconcurrent, based on Undertaking phase, and availability of funding, multiple technical inventory reports for the APE may be produced.

II. In accordance with 36 CFR § 800.4(a) and (b), NRCS, with input from the Consulting Parties, will identify the appropriate scope and level of effort needed to identify historic properties within phases of the APE, including those to which the Blackfeet Nation attaches traditional religious and cultural significance. The scope and level of effort for identification shall meet the reasonable and good faith regulatory standard (36 CFR § 800.4(b)(1)), as well as Blackfeet THPO and Montana State Historic Preservation Office (SHPO) standards and guidelines. The proposed scope and level of effort will be submitted as part of the APE consultations in Stipulation III.

III. Technical reports shall be prepared upon completion of field investigations. MRJBOC shall submit the draft report to the NRCS for review. The technical reports shall include summary background information, environment, methodology, results, analysis, recommendations for further study, maps, photos, relative scale drawings, references, and graphics as appropriate to meet 36 CFR § 800.11, NRCS policy and procedure (420 GM pt. 401; 190 NCRPH pt. 601), and be guided by Montana SHPO standards and guidelines. The reports shall provide all information necessary for NRCS to make determinations of NRHP eligibility and findings of effect. NRCS may request revisions to technical reports before they are approved. Once NRCS has approved technical reports, NRCS will provide the report to all Consulting Parties for review and comment. Report submission may be combined in one submission with NRHP determinations and assessment of effects for each phase of the Undertaking.

IV. NRCS and the Consulting Parties shall protect information about historic properties to the extent allowed by the Archaeological Resources Protection Act (ARPA) (16 U.S.C. § 470hh), and Section 304 of the NHPA (54 U.S.C. § 307103), 36 CFR § 800.11(c)). This will include specifically protecting information on properties of traditional religious and cultural significance to Indian tribes to which the Consulting Parties may become privy, including protecting location information or information provided by Indian tribes to assist in the identification of such properties.

V. Once identification efforts have been completed in a phase of the APE, NRCS, in accordance with 36 CFR § 800.4(c)(1), will review any properties identified in the phase area(s) and make a determination of eligibility for the NRHP for each resource.

a. NRCS will submit their eligibility determination(s) for each phase to Consulting Parties for review. Upon receipt, all parties will have 30 days to review and provide comments on the eligibility determinations. NRCS will consider any comments on eligibility made during this time. This submission may be combined with the technical report submission and assessment of effect for the Undertaking.

b. If NRCS and the Consulting Parties do not agree on NRHP eligibility, NRCS shall follow procedures in 36 CFR § 63 to obtain a determination of eligibility from the Keeper of the National Register of Historic Places.

5 **Phased Assessment of Effects**

a. NRCS will make an assessment of effect for the Undertaking as identification and evaluation is completed for each phase in accordance with 36 CFR § 800.5(a)(3) and described in Stipulation IV. That assessment will be updated as Stipulation IV is completed for each phase and as adverse effects, if any, are mitigated pursuant to Stipulation VI.

1. If there are no historic properties within a particular phase, or historic properties are present but will not be affected, NRCS will make a finding that no historic properties occur within this phase of the Undertaking. NRCS shall

notify all Consulting Parties and seek their concurrence. The Consulting Parties shall have 30 days from receipt to review and comment. This submission may be combined with the technical report submission and NRHP determinations for each phase of the Undertaking.

A. If, at the end of the 30-day review period, the Consulting Parties agree that no historic properties exist within the particular phase or no objection is received, NRCS may provide a signed Notice to Proceed from the State Conservationist and authorize Undertaking construction activities for that individual phase.

B. Disagreements with the phased finding of no historic properties affected within the 30-day review period shall follow the process laid out in 36 CFR § 800.4(d)(1).

2. If historic properties are present in a particular phase, NRCS, in accordance with 36 CFR § 800.5(a), will apply the criteria of adverse effects in consultation with Consulting Parties.

a) If historic properties are present but will not be adversely affected by the Undertaking, NRCS will make a finding of no adverse effect on historic properties in accordance with 36 CFR § 800.5(b). NRCS will also make a finding of no adverse effect if minimization or avoidance through conditions can occur so that there is no longer an adverse effect. NRCS shall notify all Consulting Parties of their finding and seek their concurrence. The Consulting Parties shall have 30 days from receipt to review and comment. This submission may be combined with the technical report submission and NRHP determinations for each phase of the Undertaking.

a. If, at the end of the 30-day review period, the Consulting Parties agree with the finding of no adverse effect or no objection is received, NRCS may provide a Notice to Proceed signed by the State Conservationist and authorize Undertaking construction activities for that individual phase.

b. Disagreements with the finding within the 30-day review period shall follow the process laid out in 36 CFR § 800.5(c)(2).

b) If NRCS finds that activities may adversely affect historic properties, resolution shall occur in accordance with Stipulation VI.

b. When Stipulations IV-VI have been completed for all phases of the Undertaking, NRCS will provide a final resolution letter to all consulting parties that will summarize the historic properties identified in all the phases and, if applicable, summarize actions undertaken in a mitigation plan to resolve adverse effects. No additional mitigation will occur beyond what is agreed upon in the treatment plans.

6 **Treatment/ Mitigation Plan**

i. If NRCS determines that activities may adversely affect a historic property(ies), NRCS shall consult further to resolve the adverse effect pursuant to 36 CFR § 800.6 to identify the appropriate treatment(s) that are in the public interest to avoid, minimize, and/or mitigate adverse effects to historic properties.

a. Avoidance: NRCS, in working with the Consulting Parties, shall use the information contained in identification studies to identify measures that would avoid adverse effects to historic properties. Whenever deemed feasible by NRCS, avoidance of adverse effects to historic properties shall be the preferred treatment (420 GM § 401.22; 190 NCRPH § 601.22D). NRCS will seek agreement with the Consulting Parties on avoidance measures. MRJBOC shall incorporate those avoidance measures deemed prudent and feasible by NRCS into the plans, specifications, and implementation of Undertaking construction and development.

b. Monitoring: Blackfeet TCS and SOI-qualified monitors (as needed) will be onsite during all ground-disturbing activities within the defined APE. NRCS will coordinate with the Blackfeet THPO to develop a Monitoring Plan (MP) prior to the implementation of monitoring.

  a) The MP will be appended to this Agreement within Appendix C upon development.

  b) The MP must include steps for reinitiating the Section 106 process in the event of inadvertent discoveries.

  c) NRCS shall submit the MP to the Consulting Parties. The reviewing parties shall have 30 days from their receipt of the MP to submit written comments. NRCS shall ensure that timely comments and recommendations submitted by the reviewing parties are considered in the MP.

  d) Considering timely comments and recommendations by reviewing parties, NRCS will revise and distribute the final MP to all Consulting Parties.

  e) MRJOB will be responsible for the costs related to implementation of the MP.

c. Mitigation: When agreement between NRCS and the Consulting Parties can be reached on how to resolve a finding of adverse effect, NRCS shall prepare a Mitigation Plan(s) describing the measures to be carried out, the manner in which they will be carried out, and a schedule for their implementation.

  1. The Mitigation Plan(s) will be appended to this Agreement within Appendix C and will list all historic properties located within the APE that have been identified and are subject to adverse effects. The Mitigation Plan(s) will

address all characteristics contributing to the Properties' eligibility to the NRHP and will identify the specific mitigation strategies proposed to address the direct, indirect, and cumulative effects of the Undertaking on the historic properties.

2. NRCS shall submit the Mitigation Plan(s) to the Consulting Parties and the NRCS Federal Preservation Officer (NRCS FPO). The reviewing parties shall have 30 days from their receipt of the Mitigation Plan(s) to submit written comments. NRCS shall ensure that timely comments and recommendations submitted by the reviewing parties are considered in the Mitigation Plan(s).

3. Considering timely comments and recommendations by reviewing parties, NRCS will revise and distribute the final Mitigation Plan(s) to all Consulting Parties for concurrence. Consulting Parties are to provide comments on the final Mitigation Plan(s) within 30 days, after which point the Mitigation Plan(s) will be included within Appendix C and the development process will be concluded.

4. NRCS shall ensure that MRJBOC will implement the approved Mitigation Plan(s) in areas with the potential to adversely affect NRHP-eligible properties. NRCS with the agreement of consulting parties, may give Notice to Proceed in the remaining areas within a phase that will not be adversely affected. NRCS will ensure that the sponsor has obtained all required permits and/or permissions prior to issuing the Notice for any phase of the undertaking.

5. MRJBOC will be responsible for the costs related to implementation of the Mitigation Plan(s).

6. Per Stipulation V (b), NRCS will send a final resolution letter which will include information about the completion of mitigation plans.

7 Inadvertent Discovery Plan

- NRCS and MRJBOC shall ensure that every contract for each Undertaking phase includes provisions for halting work/construction in the area when potential historic properties are discovered or unanticipated effects to historic properties are found after implementation, installation, or construction has begun.

- When a resource is discovered after Section 106 review for an Undertaking phase is complete, but work/construction has not yet begun, MRJBOC shall notify the NRCS Cultural Resource Specialist (NRCS CRS) within one business day of discovery. The NRCS CRS will reopen Section 106 consultation for that phase and follow the process outlined in Sections IV, V, and VI of this Agreement. The process must be concluded within that phase before NRCS can authorize resumption of construction.

- When a resource is discovered during construction, MRJBOC or the contractor shall halt work/construction in the area and immediately notify the NRCS State Conservationist's Office and the NRCS CRS.

- NRCS CRS shall notify the Blackfeet THPO and inspect the discovery within one business day, if weather permits, and in consultation with the Blackfeet THPO, Reclamation, and MRJBOC, the CRS shall establish a minimum protective buffer zone of 100-feet surrounding the discovery. The contractor will also put up a temporary protective boundary around the selected buffer. This action may require inspection by tribal cultural resources experts in addition to the CRS.

- MRJBOC, under NRCS guidance, shall establish security to protect the resources/historic properties, workers, and private property. Local law enforcement authorities will be notified in accordance with applicable State law and NRCS policy in order to protect the resources, and the discovery will be evaluated by a Blackfeet TCS. Construction and/or work shall not resume until written clearance is jointly issued by the Blackfeet THPO and NRCS.

- NRCS shall notify Consulting Parties, the NRCS FPO, and the ACHP no later than two business days after the discovery and describe NRCS's assessment of the NRHP eligibility of the property, as well as feasible and proposed actions to resolve any adverse effects to historic properties. The eligibility determination may require the assessment and advice of the Blackfeet THPO, TCS staff, concerned Indian tribes, and technical experts (such as historic landscape architects) not employed by NRCS.

- The Consulting Parties and ACHP shall respond within two business days from receipt of the notification with any comments on the discovery and proposed actions.

- NRCS shall take any comments provided into account and carry out appropriate actions to resolve any adverse effects in accordance with Stipulation VI of this agreement.

- NRCS shall provide a report to the Consulting Parties and the ACHP of the actions when they are completed.

7. The State Conservationist shall provide a signed Notice to Proceed to the contractor to work in the area after the identification and evaluation and resolution of adverse effects of historic properties (if applicable) have been completed. NRCS will ensure that the sponsor has obtained all required permits and/or permissions prior to issuing the Notice for any phase of the undertaking.

8 Treatment of Human Remains and Items of Religious and Cultural Significance

a. In the event human remains are encountered during either archaeological investigations or construction activity, NRCS and MRJBOC shall ensure that the remains are left in place, protected from disturbance including adverse weather, and that work within 100 feet of the remains will cease. MRJBOC will work with NRCS, the Blackfeet THPO, and Blackfeet Tribal Monitors to secure the area. Once secured, NRCS will contact the following entities immediately upon discovery: the BIA Blackfeet Superintendent, the Glacier County Sheriff's Office, and the Montana Medical Examiner's Office (MMEO). NRCS will notify Consulting Parties, including other agencies (if any) that join the Agreement per Stipulation I (c), within 24 hours of the discovery.

b. All human remains, regardless of historical age, sex, or cultural/ethnic affiliation, will be treated with dignity and respect and in a manner consistent with the ACHP's *Policy Statement on the Treatment of Human Remains, Burial Sites and Funerary Objects* (March 1, 2023) and the ACHP's Section 106 Archaeology Guidance. NRCS will also follow USDA and NRCS policy on the treatment of human remains and consultation.

c. If it is determined that the remains are more than 150 years old, NRCS will comply with the provisions outlined in the Native American Graves Protection and Repatriation Act (NAGPRA) (Public Law 101-601, 25 U.S.C. 3001). NRCS will coordinate with the Blackfeet THPO and the Montana Burial Preservation Board THPO to ensure that all Tribal laws and customs for the treatment and disposition of human remains are observed. If the remains area identified on lands controlled by Reclamation, disposition of the human remains and/or funerary objects shall be the responsibility of Reclamation per 43 CFR § 10.7.

d. If the remains are determined to be less than 150 years old, NRCS will coordinate with the MMEO to determine the ancestry and antiquity of the remains. If remains are identified as Native American and not of medicolegal significance, NRCS will coordinate with the MMEO and the Blackfeet Nation to determine the appropriate disposition.

e. Measures to protect the human remains and any associated artifact(s) will remain in effect until an appropriate Mitigation Plan(s) (following the procedure laid out in Stipulation VI) for the discovery (if applicable) has been completed for the remains and associated artifacts. The contractor will not resume work within the 100-foot buffer surrounding the remains until specifically authorized in writing by the NRCS State Conservationist and other agencies joining this agreement (if any)

9 Emergency Situations

I. Should an emergency situation occur on the Saint Mary Canal which represents an imminent threat to public health or safety, or creates a hazardous condition, NRCS will coordinate with Reclamation to immediately notify the Blackfeet THPO and the ACHP of the condition which has initiated the situation and the measures taken to respond to the emergency or hazardous condition. Should the Blackfeet THPO or the ACHP desire to provide technical assistance to NRCS and Reclamation, they shall submit comments within seven (7) calendar days from notification, if the nature of the emergency or hazardous condition allows for such coordination.

10 Duration

- The term of this PA shall be ten (10) years from the date of execution by the Invited and Required signatories.
- Prior to such time, NRCS will consult with the Required and Invited signatories to reconsider or revise the terms of the agreement and amend in accordance with Stipulation XII below.

11 Reporting

- At end of each calendar year, following the execution of this PA and until construction is complete, MRJBOC shall submit a written report to NRCS describing progress on implementation of the terms of this PA, the development of construction plans and specifications, construction completed during the period covered by the report, mitigation measures that have been implemented, the schedule for completion of mitigation, the treatment of any post-review discoveries pursuant to Stipulation VII, scheduling changes proposed, problems encountered and of relevance to this PA, and disputes addressed pursuant to Stipulation XI. Upon approval of the report, NRCS will submit this report to the Signatories.

12 Dispute Resolution

a. Should any party to this agreement object to any actions proposed or the manner in which the terms of this Agreement are implemented, NRCS shall consult with the objecting party(ies) to resolve the objection. If NRCS determines, within 30 days, that such objection(s) cannot be resolved, NRCS will forward all documentation relevant to the dispute to the ACHP in accordance with 36 CFR § 800.2(b)(2). Upon receipt of adequate documentation, the ACHP shall review and advise NRCS on the resolution of the objection within 30 days. NRCS will take into account any comment provided by the ACHP, and all comments from the parties to the Agreement in reaching a final decision regarding the dispute.

b. If the ACHP does not provide comments regarding the dispute within 30 days after receipt of adequate documentation, NRCS may render a decision regarding the dispute. In reaching its decision, NRCS will take into account all comments regarding the dispute from the parties to the Agreement.

c. The responsibility of NRCS to carry out all other actions subject to the terms of this Agreement that are not the subject of the dispute remain unchanged. NRCS will notify all parties of its decision in writing before implementing that portion of the Undertaking subject to dispute under this stipulation. NRCS's decision will be final.

13 Amendments

a. Any Required or Invited signatory to this Agreement may request in writing to the other Signatories that the Agreement be amended or extended, whereupon the Required or Invited signatories will consult for a period of no more than 30 days to consider such amendment. If any Required or Invited signatory to this Agreement determines that its terms will not or cannot be carried out or that an amendment to its terms must be made, that party shall immediately consult with the other parties to develop an amendment to this Agreement pursuant to 36 CFR § 800.6(c)(7) and § 800.6(c)(8). The amendment will be effective on the date a copy signed by all Required and Invited signatories is filed with the ACHP.

b. Appendices may be modified through consultation and written agreement between all Required and Invited signatories without requiring an amendment to this Agreement.

c. If the Required signatories cannot agree to appropriate terms to amend the Agreement, any Required or Invited signatory may terminate the agreement in accordance with Stipulation XIII below.

14 Termination

- If any Required signatory to this Agreement determines that its terms will not or cannot be carried out, that party shall immediately consult with the other Required or Invited signatories to attempt to resolve the dispute and/or develop an amendment per Stipulation XII, above. If within 30 days (or another time period agreed to by all Signatories) an amendment cannot be reached, any Required or Invited signatory may terminate the Agreement upon written notification to the other Required or Invited signatories. Once the Agreement is terminated, and prior to work continuing on the Undertaking, NRCS must either (a) execute an Agreement pursuant to 36 CFR § 800.6 or (b) request, take into account, and respond to the comments of the ACHP under 36 CFR § 800.7. NRCS shall notify the Signatories as to the course of action it will pursue.

- NRCS's obligations under this Agreement are subject to the availability of appropriated funds, and the stipulations of this Agreement are subject to the provisions of the Anti-Deficiency Act. NRCS shall make reasonable and good faith efforts to secure the necessary funds to implement this Agreement in its entirety. If compliance with the Anti-Deficiency Act alters or impairs NRCS's ability to implement the stipulations of this agreement, NRCS shall consult in accordance with the amendment and termination procedures found in this Stipulation XII and XIII of this Agreement.

15 EXECUTION

- The Agreement may be executed in counterpart.

- The Agreement will be effective on the date a copy signed by all the Required signatories is filed with the ACHP.

Execution of this Agreement by Required signatories, its submission to the ACHP, and subsequent implementation of its terms, evidence that NRCS has afforded the ACHP an opportunity to comment on the undertaking and its effects on historic properties, that NRCS has taken into account the effects of the undertaking on historic properties, and that NRCS has satisfied its responsibilities under Section 106 and applicable implementing regulations for the undertaking.

REQUIRED SIGNATORY PAGE

PROGRAMMATIC AGREEMENT
AMONG THE
US DEPARTMENT OF AGRICULTURE,
NATURAL RESOURCES CONSERVATION SERVICE MONTANA STATE OFFICE,
THE BUREAU OF RECLAMATION, MONTANA AREA OFFICE,
THE MILK RIVER JOINT BOARD OF CONTROL,
AND THE BLACKFEET TRIBAL HISTORIC PRESERVATION OFFICER
REGARDING PHASED IDENTIFICATION AND EVALUATION
OF HISTORIC PROPERTIES FOR THE
WATERSHED PLAN-ENVIRONMENTAL IMPACT STATEMENT
FOR THE MILK RIVER AND SAINT MARY WATERSHEDS,
GLACIER COUNTY, MONTANA

NATURAL RESOURCES CONSERVATION SERVICE MONTANA STATE OFFICE

Date ____

Signature ____

Printed ____

REQUIRED SIGNATORY PAGE

**PROGRAMMATIC AGREEMENT
AMONG THE
US DEPARTMENT OF AGRICULTURE,
NATURAL RESOURCES CONSERVATION SERVICE MONTANA STATE OFFICE,
THE BUREAU OF RECLAMATION, MONTANA AREA OFFICE,
THE MILK RIVER JOINT BOARD OF CONTROL,
AND THE BLACKFEET TRIBAL HISTORIC PRESERVATION OFFICER
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OF HISTORIC PROPERTIES FOR THE
WATERSHED PLAN-ENVIRONMENTAL IMPACT STATEMENT
FOR THE MILK RIVER AND SAINT MARY WATERSHEDS,
GLACIER COUNTY, MONTANA**

BLACKFEET TRIBAL HISTORIC PRESERVATION OFFICER

Date ____

Signature ____

Printed ____

INVITED SIGNATORY PAGE

PROGRAMMATIC AGREEMENT
AMONG THE
US DEPARTMENT OF AGRICULTURE,
NATURAL RESOURCES CONSERVATION SERVICE MONTANA STATE OFFICE,
THE BUREAU OF RECLAMATION, MONTANA AREA OFFICE,
THE MILK RIVER JOINT BOARD OF CONTROL,
AND THE BLACKFEET TRIBAL HISTORIC PRESERVATION OFFICER
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WATERSHED PLAN-ENVIRONMENTAL IMPACT STATEMENT
FOR THE MILK RIVER AND SAINT MARY WATERSHEDS,
GLACIER COUNTY, MONTANA

BUREAU OF RECLAMATION, MONTANA AREA OFFICE

Date ____

Signature ____

Printed ____

INVITED SIGNATORY PAGE

PROGRAMMATIC AGREEMENT
AMONG THE
US DEPARTMENT OF AGRICULTURE,
NATURAL RESOURCES CONSERVATION SERVICE MONTANA STATE OFFICE,
THE BUREAU OF RECLAMATION, MONTANA AREA OFFICE,
THE MILK RIVER JOINT BOARD OF CONTROL,
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WATERSHED PLAN-ENVIRONMENTAL IMPACT STATEMENT
FOR THE MILK RIVER AND SAINT MARY WATERSHEDS,
GLACIER COUNTY, MONTANA

MILK RIVER JOINT BOARD OF CONTROL

Date ____

Signature ____

Printed ____

CONCURRING PARTY SIGNATORY PAGE

**PROGRAMMATIC AGREEMENT
AMONG THE
US DEPARTMENT OF AGRICULTURE,
NATURAL RESOURCES CONSERVATION SERVICE MONTANA STATE OFFICE,
THE BUREAU OF RECLAMATION, MONTANA AREA OFFICE,
THE MILK RIVER JOINT BOARD OF CONTROL,
AND THE BLACKFEET TRIBAL HISTORIC PRESERVATION OFFICER
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OF HISTORIC PROPERTIES FOR THE
WATERSHED PLAN-ENVIRONMENTAL IMPACT STATEMENT
FOR THE MILK RIVER AND SAINT MARY WATERSHEDS,
GLACIER COUNTY, MONTANA**

BLACKFEET NATION OF THE BLACKFEET INDIAN RESERVATION OF MONTANA

Date ____

Signature ____

Printed ____

CONCURRING PARTY SIGNATORY PAGE

**PROGRAMMATIC AGREEMENT
AMONG THE
US DEPARTMENT OF AGRICULTURE,
NATURAL RESOURCES CONSERVATION SERVICE MONTANA STATE OFFICE,
THE BUREAU OF RECLAMATION, MONTANA AREA OFFICE,
THE MILK RIVER JOINT BOARD OF CONTROL,
AND THE BLACKFEET TRIBAL HISTORIC PRESERVATION OFFICER
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WATERSHED PLAN-ENVIRONMENTAL IMPACT STATEMENT
FOR THE MILK RIVER AND SAINT MARY WATERSHEDS,
GLACIER COUNTY, MONTANA**

U.S. BUREAU OF INDIAN AFFAIRS, ROCKY MOUNTAIN REGION OFFICE

Date ____

Signature ____

Printed ____

CONCURRING PARTY SIGNATORY PAGE

**PROGRAMMATIC AGREEMENT
AMONG THE
US DEPARTMENT OF AGRICULTURE,
NATURAL RESOURCES CONSERVATION SERVICE MONTANA STATE OFFICE,
THE BUREAU OF RECLAMATION, MONTANA AREA OFFICE,
THE MILK RIVER JOINT BOARD OF CONTROL,
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WATERSHED PLAN-ENVIRONMENTAL IMPACT STATEMENT
FOR THE MILK RIVER AND SAINT MARY WATERSHEDS,
GLACIER COUNTY, MONTANA**

U.S. ARMY CORPS OF ENGINEERS, OMAHA DISTRICT OFFICE

Date ____

Signature ____

Printed ____

APPENDIX A
Description of the APE and Associated Maps

The Saint Mary Canal is a 29-mile irrigation conveyance system that diverts water from the Saint Mary River near Babb, Montana into the Milk River Northwest of Cut Bank, Montana for delivery to agricultural producers in North-Central Montana near Havre. The canal system includes a diversion dam; three siphons (Kennedy Creek Siphon, Saint Mary Siphon, and Halls Coulee Siphon); three wasteway and check dam structures (Kennedy Creek Wasteway and Check, Spider Lake Check Dam, and Halls Coulee Wasteway); and five drop structures (Drops 1-5). Reclamation began construction on the Saint Mary Canal in 1907 and continued through the next four decades. The system is considered a significant historic resource for its contributions to the history of the country and the region. The canal also has historical significance for the unique design of its corridor and features in conveying water from the Saint Mary River to the Milk River.

NRCS currently defines the APE for this undertaking as the footprint of Alternatives 2 and 3, of the Watershed Plan-EIS which total 1,240.28 acres. This includes a 300-foot-wide corridor (150 feet either side of centerline) for the proposed canal, Kennedy Creek siphon, and wasteway modernizations; a 100-foot-wide corridor (50 feet either side of centerline) on O&M roads requiring modernization; a 1,000-foot diameter construction footprint centered on Drop Structures 1, 3, and 4; and a 100-foot buffer around the perimeters of two proposed material source pits near Babb. The diversion dam, Saint Mary Siphon, Halls Coulee Siphon, and Drop Structures 2 and 5 are within the APE but are excluded from the current study as they have been repaired and replaced within the last 10 years or are in the process of being repaired and replaced under separate Federal undertakings.

Additional construction extents, material sources, staging areas, and laydown yards may be required for this undertaking, but these have not been identified and have not been included in the current APE. The APE is subject to refinement through development of NEPA and additional Section 106 consultation for the selected Alternative.

Map 1

Map 2

Map 3

Map 4

Map 5

Map 6

Map 7

Map 8

Map 9

APPENDIX B

Consulting Parties and Contact Information

Illiff "Scott" Kipp Sr., Chairman
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APPENDIX C
Monitoring and Treatment/Mitigation Plans

TBD

Appendix D5. Economic Investigation and Analysis

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D5.1 Introduction

The St. Mary Canal (canal) was constructed in the early 1900s by the Bureau of Reclamation to divert flow from the St. Mary River to the Milk River Basin and supply northcentral Montana with water for agriculture irrigation. The Milk River Project, often referred to as "the lifeline of the Hi-Line," was authorized on March 25, 1905, as a single-purpose irrigation project. This means that irrigators are responsible for the operation, maintenance, and replacement costs of the facilities.

The St. Mary Canal System consists of an earthen canal, three siphons, five drop structures, the canal access road, wasteways, and drains. The length of the canal system from the diversion of the St. Mary River to the discharge into the Milk River is 29 miles. The canal and related structures were originally designed to convey 850 cubic feet per second (cfs), in accordance with existing water rights. After canal water exits from the canal drop structure into the Milk River near the US/Canada border, the Milk River flows through Canada for 216 miles. This water is used for irrigation and by municipalities before returning to the United States. Milk River water is stored in Fresno Reservoir, located 14 miles west of Havre, and in Nelson Reservoir, located 19 miles northeast of Malta. Delivered water is used for domestic water supply for approximately 18,000 residents and for farmers irrigating approximately 120,000 acres along a 165-mile stretch of the Milk River in Hill, Blaine, Phillips, and Valley Counties.

Currently, it is estimated that, on average, 175,339 AF per year are diverted over a 6-month period between April and October, which is less than the original intended design and water right. The reduced level of diversion is due to several factors, including concerns about structural integrity of the siphons, canal, and other infrastructure components.

The purpose of the project is to improve agricultural water management by rehabilitating and modernizing the canal along its existing alignment in Glacier County, Montana. The proposed project is needed due to existing system delivery inadequacies and the risk of infrastructure failure. This has reduced water delivery reliability to users who rely on the canal for agricultural, municipal, residential, industrial, and recreational uses. The alternatives presented for this project are based on the combination of improvements that could be made to the St. Mary Canal System to meet the project purpose and need while considering multiple federal requirements to streamline the planning and decision-making process. The alternatives developed include the No-Action and Action Alternatives. The Action Alternatives combine several different structural elements that aim to increase canal water conveyance, enhance reliability of structural elements of the St. Mary Canal System, and enhance the maintenance efficiency in the case of a system component failure.

D5.2 Federal Guidelines of National Economic Efficiency Analysis

A National Economic Efficiency (NEE) benefit-cost analysis (BCA) has been performed to evaluate benefits of the Action Alternatives. The evaluation includes an identification of damages sustained under the No-Action Alternative, also known as the Future Without Federal Investment (FWOFI), and estimates the benefits associated with each Action Alternative. This analysis relies on federal water resource project and US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) guidelines for the evaluation of NEE benefits and costs. These guidelines rely primarily on the Principles, Requirements, and Guidelines (PR&G) (CEQ 2014), the NRCS Natural Resources Economics Handbook (NRCS 1998), and the National Watershed Program Manual (NRCS 2014b).

With the passage of the 2007 Water Resources Development Act, federal agencies were directed to update the original Principles and Guidelines (P&G) from 1983. This update resulted in the creation of the PR&G. The revised purpose of the PR&G is to allow for:

> *"… maximizing public benefits (of all types) relative to costs, the use of quantified and unquantified information in the tradeoff analysis, flexibility in decision-making to promote localized solutions, ability to rely on the best available science and objectivity, and advance transparency for federal investments in water resources."*

Further expanding the guidance on benefits, the PR&G states:

> *"Public benefits encompass environmental, economic, and social goals; include monetary and non-monetary effects; and allow for the consideration of both quantified and unquantified measures."*

The PR&G guide projects to be evaluated from an ecosystem services perspective. In order to receive federal investment, water projects must strive to:

> *"…protect and restore the functions of ecosystems and mitigate any unavoidable damage to these natural systems."*

The updated PR&G give equal standing to economic, social, and environmental impacts when selecting the preferred alternative. This includes both monetized and non-monetized valuation methods, which allows the analysis to fully articulate the impacts the project provides. Equal standing also allows the project to best meet the Federal Objective of maximizing public benefits and costs while protecting ecosystem services.

D5.3 National Economic Efficiency Benefits Analysis Data, Methodology, and Results

This economic analysis of alternatives entails evaluating the benefits of specific project measures relative to their cost. Project measures are listed in Table D5-1. Three Alternatives, defined in relative to project measures, include:

- Alternative 1 (No Action/FWOFI): No project measures are implemented;
- Alternative 2: All project measures are implemented;
- Alternative 3: All project measures, except canal lining, are implemented.

Table D5-1: Comparison of Alternatives

Project Measure	Alt 1	Alt 2	Alt 3
Canal shaping		X	X
Canal lining		X	
Siphon replacement		X	X
Drop structure replacement		X	X
Underdrain repair		X	X
Slope stability improvement		X	X
Maintenance road		X	X
Wasteway & spillways		X	X

The analysis is performed consistent with NRCS guidance (2023)[10] and uses data and methods from a relatively recent evaluation of the Milk River Project prepared in 2019 for the Bureau of Reclamation (Reclamation 2019).[11] Similarly, project benefits include: (a) Water use: downstream of the Fresno Reservoir, water is used for agricultural, municipal, and industrial purposes; and, (b) Recreational activity: changes in water levels in both Fresno and Nelson Reservoirs can influence the feasibility of fishing and other activities.

The value of each alternative is determined from the benefits of each project measure. The value of each project measure is evaluated separately to determine an incremental contribution to total project benefits. The value of a project measure is estimated relative to three types of benefits related to their contribution to increase water conveyance, enhance reliability, and enhance maintenance efficiency. Project measures related to each category of benefits include:

1. **Increase water conveyance.** All project measures are necessary to increase diversion of water from 175,339 AF per year to 193,266 AF per year (with lining in Alternative 2) or 186,482 AF per year (without lining in Alternative 3). The measures associated directly with conveyance alone include:
    a. Canal Shaping –This measure is included in both Alternative 2 and 3 to improve conveyance overall.
    b. Canal Lining – This measure avoids seepage from the canal, if this measure is excluded. This measure is included only in Alternative 2.
2. **Enhance reliability.** The reliability of water supply is associated with the continuity of water supply delivery to the Fresno Reservoir. Risks to reliability are analyzed relative to a probability of failure and the consequences of failure related to canal closure until the canal is reconstructed. Several different canal elements have the potential to fail. Each of these has a different probability of failure over time, which would cause a different duration of canal closure. The measures that enhance reliability include:
    a. Siphon Replacement

[10] NRCS (2023). Title 390 – National Watershed Program Manual. Watershed Program Management. Part 500. Accessed from: USDA.gov

[11] US Bureau of Reclamation (Reclamation), 2019. Economic Benefit Analysis and Repayment. Milk River Project, north-central Montana Great Plains Region. September 2019.

   b. Drop Structure Replacement
   c. Underdrain Repair
   d. Slope Stability Improvement
   e. Embankment failure

3. **Enhance maintenance efficiency.** Two project measures included in Alternatives 2 and 3 would enhance maintenance efficiency by affecting the time that the canal is closed if a structure fails. If these measures are *excluded* from the project, the duration of canal closure would increase. The benefits of including these measures are estimated from the reduced delay of canal closure (and increased water deliveries) due to a structural failure. The measures that support the need to enhance reliability include:
   a. Improved Maintenance Road – An improved maintenance road would reduce the total time needed to address a failure of any component of the Canal System.
   b. Wasteways with spillways – Operable wasteways with spillways allow for the evacuation of water from the canal upstream of any potential canal failure.

D5.3.1 Benefits Analysis

The economic analyses of Alternatives 2 and 3 entail separate evaluations of benefits and costs of individual project measures listed in Table D5-1. The benefits of a project measure are determined by the value of that incremental improvement in water supply and recreational value. The value of structures account for the probability of failure and duration until the structure is repaired. The value of canal shaping and lining relate to reduced losses over the entire period that a canal is used to divert water.

This analysis draws from some of the data and results reported in Reclamation's Economic Benefit Analysis and Repayment report (Reclamation 2019), which analyzed benefits of water use (i.e., agricultural and rural water supply) and recreational activity associated with water supplies in the Fresno Reservoir. The reported economic values are in 2018 dollars. This analysis updates economic values to 2025 dollars using several different indices and data sources, including:

- Farm revenue: Revenue is estimated using production estimates from Reclamation (Reclamation 2019) and current USDA normalized prices for crops in Montana to determine farm revenue available from the Economic Research Service (ERS).[12]
- Farm expenses: Farm production costs, as well as costs and returns to farm families, are brought to 2025-dollar terms using the National Agricultural Survey Statistics Producer Price Index.
- Recreational value of reservoir: The Consumer Price Index (CPI) is applied to adjust the value of a recreational day from 2018 to 2025 dollars.

[12] Normalized Prices. USDA ERS - Normalized Prices. (n.d.). https://www.ers.usda.gov/data-products/normalized-prices.

The BCA compares present value benefits and costs to assess the societal value of the project. Benefits are computed on a present value basis, assuming 100 years of increased water diversions and using a 3.25 percent discount rate, based on current Reclamation guidance. The planning horizon of 100 years is consistent with the age of existing project elements and an anticipated average annual cost for Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) that is estimated at 2 percent of the capital cost for each project element.

D5.4 Water Delivery Benefits

This section discusses the approach to valuing water for consumptive purposes, including irrigation and municipal and industrial (M&I) users who are downstream from the Fresno Reservoir. Values for both irrigation and M&I are data drawn from a recent study by Reclamation (Reclamation 2019) related to dam safety at the Fresno Reservoir. This analysis evaluated impacts on water availability for similar uses if the dam is breached or the water elevation is restricted.

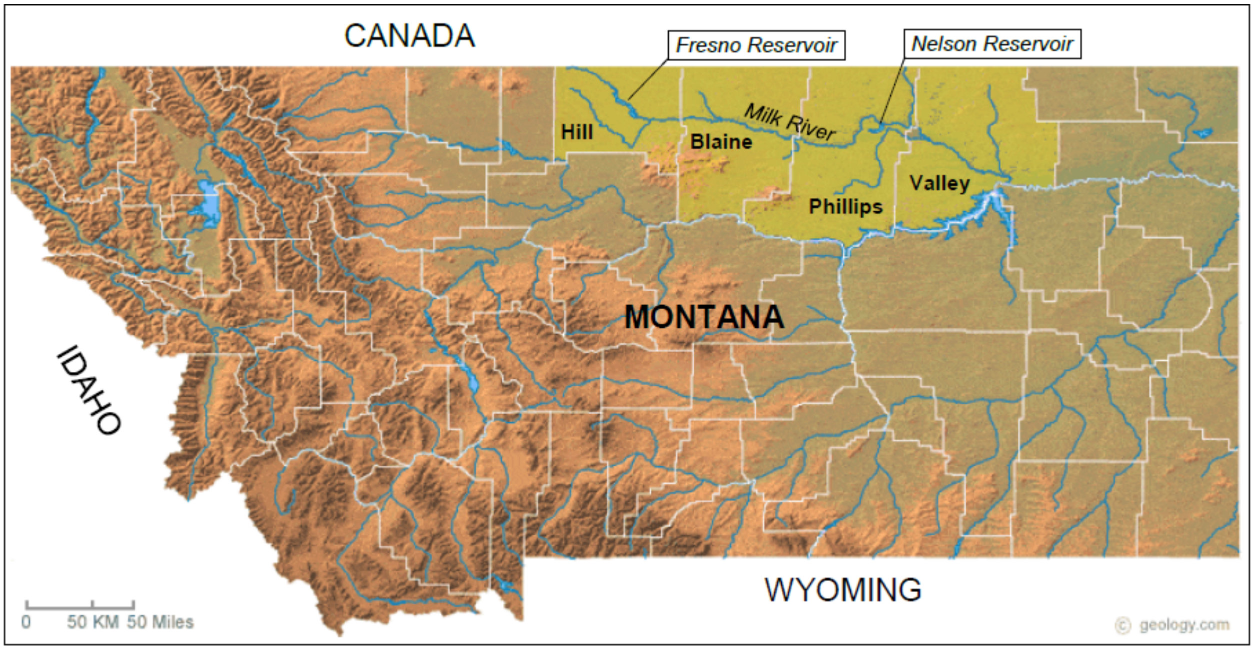
D5.4.1 Water Delivery Value

Baseline Conditions - Agricultural Production and Irrigation

Along the project area, a number of agricultural producers rely on the water provided by the Fresno Dam and Milk River Project. The Milk River project provides irrigation water to agricultural land ranging from grazing pastures to barley (Reclamation, 2019). The irrigated lands analyzed within the reclamation study, and therefore this study, lie solely in the Montana counties of Hill, Blaine, Phillips, and Valley. Figure D5-1 depicts the irrigation region in respect to the Milk River Project.

Among the users there are three distinct types: river pumpers, private land irrigators, and reservation users. Each of these users currently hold contracts with Reclamation or the state of Montana. If a project failure for the existing components occurs, all three user types could possibly lose availability to some irrigation water. With each of the proposed projects, it expected that irrigation water deliveries will be met. This means that the project development will not disrupt irrigation users outside of project construction.

Figure D5-1: Irrigation Counties of Interest



Source: Adaptation of Montana Physical Map (Geology.com, 2018)

According to Reclamation's (2019) analysis over 140,000 acres of farmland is irrigated in the project area. Users include Irrigation Districts, District Pumpers, River Pumpers, Private Land Irrigators, and Reservation Users. Table D5-2 includes the distribution of land irrigated by Producers within the project area. Data on the specific crops, yields and returns that could be affected by changes in irrigation are discussed in the next section.

Table D5-2: Milk River Project Irrigator Distribution

Irrigator	Irrigated Acres	JBOC Member
Irrigation districts	101,134	Y
District pumpers	559	Y
River pumpers	8,211	N
Private land irrigators	25,000	N
Reservation	5,500	N
Total JBOC irrigated acres	101,693	
Total Non-JBOC irrigated acres	38,711	
Total Irrigated Acres	**140,404**	

Irrigation Water Value

Benefits of additional irrigation water are revealed by the increased land productivity and change in net returns to farming. Reclamation (2019) determined the value of additional water for irrigation by estimating a marginal value of water ($ per acre-foot [AF]) based on an increase in productivity at representative farms with and without irrigation. That analysis compared two different farming systems comprised of different cropping patterns, respective acreages, and yields along with expenses, crop prices, and rate of returns to the farm family. The results generated a value of water per AF as the difference in net returns with and without irrigation.

In this analysis, much of the 2019 Reclamation analysis is replicated but with a few notable changes. First, 2019 Reclamation analysis assumed that one of the crops (peas) would be shifted to barley or alfalfa if irrigation were available. However, given the relatively high price for peas (based on regional USDA normalized prices), it is unlikely that farmers would shift from peas if irrigation water were available. Instead, it is assumed that more acres of dryland barley, compared to the 2019 Reclamation analysis, are shifted to irrigated barley. It is assumed that any changes in cropping patterns since the 2019 analysis would not have a significant impact on the value of water for irrigation.

The results of this approach capture the difference in revenue per AF of water. As a first step, the difference in revenue with and without the project are computed in Table D5-3. As shown, the revenue with irrigation access amounts to about $402.7 thousand with 3,000 acres of production. In comparison, only dryland farming would generate about $346.1 thousand, with a different mix of crops on the same acreage. Table D5-4 presents data on the Crop Income, Costs, and Net Income per Acre. Costs are updated from 2018 to 2025 dollars using the NASS Produce Price index. Next, total net benefits with the project are presented in Table D5-5. The results indicate that farm irrigation benefits amount to about $24.4 thousand. The last step, shown in Table D5-6, divides the net returns to irrigation access by the volume of water diverted for irrigation for this type of farming system. The results indicate that the value per AF of water is now estimated to be $69.64, compared to the 2019 Reclamation analysis, which was $24.96.

Table D5-3: Comparisons of Farm Returns in Representative Farms, with and without irrigation

	Yields	Units	Acres	Total Production	Total sold	Price	Revenue
Without-Irrigation Crops							
Irrig. alfalfa FP	3.46	tons	0	0	0	$191.20	$0.00
Irrig. alfalfa Est.	2.08	tons	0	0	0	$191.20	$0.00
Irrig. barley	70	BU	0	0	0	$5.34	$0.00
Irrig. pasture	2.50	AUM	0	0	0	$34.31	$0.00
Dryland pasture	0.28	AUM	1,380	386.40	386.40	$34.31	$13,257.52
Dryland spr. wht.	20	BU	1,050	21,000	21,000	$7.08	$148,680.00
Dryland barley	40	BU	420	16,800	16,800	$5.34	$89,712.00
Dryland peas	16.10	CWT	150	2,415	2,415	$39.10	$94,426.50
Total			**3,000**				**$346,076.02**

	Yields	Units	Acres	Total Production	Total sold	Price	Revenue
With-Irrigation Crops							
Irrig. alfalfa FP	3.46	tons	80	276.80	276.80	$191.20	$52,924.16
Irrig. alfalfa Est.	2.08	tons	20	41.60	41.60	$191.20	$7,953.92
Irrig. barley	70	BU	70	4,900	4,900	$5.34	$26,166.00
Irrig. pasture	2.50	AUM	30	75	75	$34.31	$2,573.28
Dryland pasture	0.28	AUM	1,350	378	378	$34.31	$12,969.32
Dryland spr. wht.	20	BU	1,000	20,000	20,000	$7.08	$141,600.00
Dryland barley	40	BU	300	12,000	12,000	$5.34	$64,080.00
Dryland peas	16.10	CWT	150	2,415	2,415	$39.10	$94,426.50
Total			**3,000**				**$402,693.17**

Table D5-4: Crop Income, Costs, and Net Income per Acre

Crop	Income ($/ac)	Cost ($/ac)	Net Income ($/ac)
Irrigated			
Alfalfa FP	$661.55	$725.58	-$64.03
Alfalfa Est.	$397.70	$436.19	-$38.49
Barley	$373.80	$409.98	-$36.18
Pasture	$85.78	$94.08	-$8.30
Dryland			
Spring wheat	$141.60	$155.30	-$13.70
Barley	$213.60	$234.27	-$20.67
Peas	$629.51	$690.44	-$60.93
Pasture	$9.61	$10.54	-$0.93

Table D5-5: Computation of Farm Net Benefits With-Irrigation

Contributing Factors to Net Return	With-Irrigation	Without-Irrigation
Farm Acreage		
Crop acres	3,000	3,000
Irrigated crop acres	*200*	*0*
Non-irrigated crop acres	*2,800*	*3,000*
Farmstead, roads, waste acres	150	150
Total farm acres	**3,150**	**3,150**
Gross Farm Income		
Total gross farm income	**$402,693.17**	**$346,076.02**
Farm Expenses		
Total farm expenses (including variable and fixed)	**$441,667.73**	**$410,821.18**
Net farm income	**-$38,974.55**	**-$64,745.15**
Return to Farm Family		
Total return to farm family (including return to management and labor)	**$53,116.35**	**$51,718.77**
Net farm returns (NFR)	**-$92,090.91**	**-$116,463.92**
With-Irrigation net benefit	**$24,373.02**	

Table D5-6: Value per AF of Water for Farm Irrigation

	Reclamation (2019)	Current Analysis
With-Project farm irrigation benefit (2018 $)	$8,735.50	$24,373.02
With-Project farm irrigated acres	200	200
Annual irrigation diversions per acre (AF/acre)	1.75	1.75
With-Project farm annual irrigation diversions (AF)	350	350
Annual benefit per AF (2018 $)	**$24.96**	**$69.64**

Baseline Conditions - Municipal and Industrial Water Supply

The canal provides water to approximately 18,000 residents in the Milk River Basin. These residents live in the communities of Havre, Chinook, Harlem, Hill County, and North Havre Water District. Reclamation (2019) summarized data from several different sources and time periods to establish an estimate of baseline water demand for M&I Contractors. These data are presented in the table below.

Table D5-7: Milk River Project M&I water diversions

M&I contractor	Contracted AF	Average Diversions	Date Range For Average Use	% of Contract Used on Average
City of Chinook	700	287	2008-17	41%
City of Harlem	500	114	2005–16	23%
City of Havre	2,800	1,671	2004-17	60%
Grand View Cemetery, Saco	14	No reports	N/A	N/A
GSA – Piegan Border Station	15	7	2016–17	44%
Hill County Water	500	0	2010–17	0%
North Havre County Water	100	No reports	N/A	N/A
Total	**4,629**	**2,079**		**45%**

M&I Water Value

The value of water for M&I uses is based on a willingness to pay (WTP) for its use and reflects the opportunity cost for the next best alternative source. The 2019 Reclamation analysis analyzed M&I water values from water rights transactions data obtained from a publication, *Water Strategist*, between 1987 and 2010 and identified one transaction—from June 2008—that represented M&I water value. The 2019 Reclamation analysis determined a water value to be $236.26 per AF in 2018 dollars, which would be $301.43 per AF in 2025 dollars.[13] However, because the 2019 Reclamation analysis relied on a single transaction that was relatively old, this approach may not reflect the best estimate of the value of alternatives to M&I use of water. Accordingly, a more conservative approach is taken that assumes the value of M&I water to be equal to the value for its use in irrigation, or $69.64 per AF.

Allocation of Water

Table D5-8 shows the results from recent field measurements indicate that about 9.4 percent of an original diversion of 600 cfs can be characterized as environmental losses (through seepage,

[13] The project is assumed to be the lowest cost alternative source of water, compared to say, groundwater pumping.

evaporation, and evapotranspiration).[14] These amounts are based on a flow rate reduction of 56.6 cfs (in all forms) relative to 600 cfs. The remaining 91.6 percent of diverted water is divided between a diversion of 180,000 AF for 120,000 irrigated acres for irrigation and 2,600 AF for M&I. This differentiation of water by uses does not affect the BCA since both water uses are assumed to have the same water value per unit.

Table D5-8: Consumptive Uses and Losses in the Canal System, Basin Wide

Consumptive Uses and Losses	Percent of Uses and Losses in Total Diversions
Losses: seepage, reservoir, and channel evaporation, phreatophyte evapotranspiration	9.4%
Consumptive uses (including agricultural irrigation and M&I, rural domestic uses)	91.6%
1. Agricultural irrigation	*98.6% of total consumptive uses*
2. M&I and rural domestic	*1.4% of total consumptive uses*
Total consumptive uses and losses	**100.00%**

Combined Water Value

A combined value for all consumptive water uses from Fresno Reservoir is computed as a weighted average across the percentages of water for irrigation and M&I. Since M&I water value is assumed to be the same as agricultural irrigation water value, the combined value of water is simply $69.64 per AF and only applies to *delivered* water, after accounting for losses from *diverted* water.

D5.4.2 Water Delivery Benefits of Increased Water Conveyance

Overview

Alternatives 2 and 3 include individual project measures to increase water conveyance, improve reliability, and enhance maintenance efficiency. The difference between Alternatives 2 and 3 is canal lining is included in Alternative 2 and not in Alternative 3. The benefits of canal lining are associated with avoided water seepage losses where lining is installed.

This section computes total discounted and annualized benefits and losses of project measures for the three alternatives to a common discount year of 2025. The next section develops the new present value by evaluating the discounted value benefits and losses relative to the years when the benefits and costs occur, due to a staggered construction schedule.

Change in Volume

Table D5-9 presents the difference in volumes delivered to users for Alternatives 2 and 3. These modeled values represent the increase in deliveries above Alternative 1, the No-Action/FWOFI

[14] These values differ from Reclamation (2019).

Alternative. Alternative 2, due to a reduction of seepage losses because of canal lining for the first 9 miles, results in an additional water delivered to the Milk River.

Table D5-9: Volumetric Impact of Project Measures to Increase Conveyance

St. Mary Canal Water Deliveries	Alternative 1 No Action	Alternative 2 Water Deliveries	Alternative 3 Water Deliveries
Actual Amount of Water Diverted from St. Mary River from 1979 to 2004, assumed to continue (AF/yr)	175,339		
Total Max Diversion Based on Water Available (AF/yr)	182,124	205,937	205,937
Additional Water Diverted Due to Increased Capacity (AF/yr)	0	23,813	23,813
Seepage Losses (AF/yr) (*Assumes 180 days*)	17,180	12,671	19,455
Total Water Delivered to North Fork of Milk River (AF/yr)	164,944	193,266	186,482
Additional Water Delivered to North Fork of Milk River (AF/yr)	0	28,322	21,538

Water Delivery Benefits of Increased Conveyance

Table D5-10 presents the results of the analysis of benefits for increasing water conveyance. The value of all three alternatives is determined by multiplying the total volume of water delivered by the value per water use. The table indicates that the difference in diverted water, between with-project and current capacity. After accounting for evapotranspiration and other losses, the delivered annual acre-feet (AAF) amounts to about 28.3 AAF with lining and 21.5 AAF without lining. The present value of benefits for these two levels of delivered water are computed by combining delivered AAF with the value per AF. The resulting benefits of increasing diversion amount to $58.21 million for Alternative 2 and $44.26 million for Alternative 3. Implicitly, the benefits of canal lining, evident in the difference in benefits between Alternatives, amounts to about $13.9 million.

Table D5-10: Discounted Value of Increased Water Conveyance ($M)

	Alternative 1	Alternative 2	Alternative 3
Water delivered (AAF)	164,944	193,266	186,482
Discounted value of water deliveries (to users)	$338.99	$397.20	$383.26
Annualized value of water deliveries (to users)	**$11.49**	**$13.46**	**$12.99**
Discounted benefits, action alternatives		**$58.21**	**$44.26**

D5.4.3 Water Delivery Enhanced Reliability Benefits

The failure of individual structural features of the canal, such as siphons and drop structures, would cause an immediate shut down of the canal and complete loss of water deliveries until those structures are reconstructed. This would result in less total inflow to Lake Fresno and Lake Nelson. Water stored in Lake Fresno is used for recreation, irrigation, and municipal use by Havre, North Havre, Chinook, and Harlem. Water stored in Lake Nelson is used for irrigation and recreation. For each project measure, the annual probability of failure is multiplied by the value of water that could be delivered to determine the annual benefit of replacing them in this project (i.e., before a failure). Many of the more vulnerable structures have outlasted their expected lifespan and face a high likelihood of failure. Recent durability-related failures of a drop structure and St. Mary Siphon indicated that similar risks are faced by other structures. This data was considered in developing the forecast of failure rates in this analysis.

Probability of Failure

This analysis uses high-level assessments of annual probabilities of failure for Kennedy Creek Siphon and drop structures. These assessments are based on best professional judgment and are found in Table D5-11. This data indicates that Kennedy Creek Siphon[15] has an annual chance of failure of 33 percent per year until 2028. Over the next 5 years, the annual probability increases to 42 percent and ultimately to 100 percent likelihood of failure by 2038. By comparison, the annual probabilities of failure for drop structures are assumed to be 50, 60, and 70 percent, respectively, and eventually reach an imminent failure state by 2049. Embankment failure is anticipated to be caused by damage due to animal intrusion/burrowing based on maintenance efforts to address current canal conditions. Table D5-11 also presents data on the failure probabilities for project measures after they are replaced or repaired by the project.

Table D5-11: Annual Probability of Failure, per Time Period

Potential Failures	Period of Years					
No Action Condition (Alt 1)	**2025 – 2028**	**2028 – 2033**	**2033 – 2038**	**2038 – 2043**	**2043 – 2048**	**Long Term**
Siphon failure	33%	42%	54%	100%	100%	100%
Drop structure failure	50%	60%	70%	80%	90%	100%
Underdrain failure	60%	70%	80%	90%	100%	100%
Slope stability failure	30%	40%	50%	50%	50%	50%
Embankment failure	80%	80%	80%	80%	80%	80%
Action Condition (Alts. 2 or 3)	**2025 – 2034**	**2034 – 2044**	**2044 – 2054**	**2054 – 2064**	**2064 – 2074**	**Long Term**
Siphon failure	0%	1%	2%	3%	9%	21%
Drop structure failure	1%	2%	5%	10%	25%	50%
Underdrain failure	1%	2%	5%	10%	25%	50%
Slope stability failure	2%	5%	10%	10%	10%	25%
Embankment failure	5%	10%	10%	10%	25%	50%

Consequences of Failure

The project team has estimated the number of months that would be required for repair and replacement if a structure fails. During this period of reconstruction, it is assumed that the canal would be completely closed. Table D5-12 provides the range of months of canal closure for the failure of each structure. It is assumed that replacing and repairing these structures prior to a failure could be implemented without closing the canal when it is diverting water. In the analysis, the average number of months of canal closure is used to compute benefits (i.e., 21 months is the period of canal closure for a siphon failure). For each of these periods, the consequences of failure multiply the months of closure by the volume of delivery during that period based on the current delivery of water. That is, the consequences of a failure are monetized from the value of reduced water deliveries, based on current delivery of water, over the months of canal closure pertaining to the structure that fails. Since the losses are based on current water diversions

[15] The chance of siphon failure is Kennedy Creek Crossing Siphon only and does not include St. Mary Siphon (replaced in 2025) or Halls Coulee Siphon (replaced in 2026).

only, the impact of a structural failure is the same for Alternatives 2 and 3 and based only on the volumes delivered in Alternative 1.

Table D5-12: Reconstruction Period for a Failure of Individual Project Measures

Potential Failures	Period of Canal Closure, if Failure (Months)	Modeled Canal Closure Consequences (Months)
Siphon	18 to 24 months	21
Drop structure	4 to 5 months	4.5
Underdrain	1 month	1
Slope stability	1 month	1
Embankment	0.5 month	0.5

Failure Mode Analysis

The structural failures discussed all share a principal factor in the cause of failure—the water carried by the canal. However, if any such failures occur, the canal is closed, and no water is conveyed until repairs are complete. Accordingly, it is reasonable to assume that these failures cannot occur at the same time. Thus, the failure of any one structure depends on other structures not failing.

A complicating factor in this analysis is that the consequences of a siphon failure could last nearly 2 years (modeled as a delay in water delivery for 21 months). Accordingly, the annual probabilities shown in Table D5-12 are modified to be determined on a 3-year period to account for losses of water due to a sequence of failures of different structures. The probability of failure for any structure and future period is computed from the equation: *Prob*(Failure in Three Years) = 1- [Prob(No Failure in One Year)]^3.[16] Since there are only two conditions for a structure, the probability of No Failure in One Year is 1 minus the probability of a Failure in One Year. As expected, the 3-year probabilities of failure in Table D5-13 are higher than those in Table D5-12 since a single failure could occur over a longer period of time. The failure of any structure still has the same consequences of a canal closure, as represented in Table D5-13.

Table D5-13: 3-Year Probability of Failure, per Time Period

Potential Failures	Period of Years					
No Action Condition (Alt 1)	**2025 – 2028**	**2028 – 2033**	**2033 – 2038**	**2038 – 2043**	**2043 – 2048**	**Long Term**
Siphon failure	70.0%	80.0%	90.0%	100.0%	100.0%	100.0%
Drop structure failure	87.5%	93.6%	97.3%	99.2%	99.9%	100.0%
Underdrain failure	93.6%	97.3%	99.2%	99.9%	100.0%	100.0%
Slope stability failure	65.7%	78.4%	87.5%	87.5%	87.5%	87.5%
Embankment failure	99.2%	99.2%	99.2%	99.2%	99.2%	99.2%

[16] This equation simply means that the probability of a failure in a three-year period is equal to 1 minus the probability that no failure has occurred in those three years, which is the probability of no failure in one year, tripled.

Potential Failures	Period of Years					
Action Condition (Alts. 2 or 3)	**2025 – 2034**	**2034 – 2044**	**2044 – 2054**	**2054 – 2064**	**2064 – 2074**	**Long Term**
Siphon failure	1.0%	2.0%	5.0%	10.0%	25.0%	50.0%
Drop structure failure	3.0%	5.9%	14.3%	27.1%	57.8%	87.5%
Underdrain failure	3.0%	5.9%	14.3%	27.1%	57.8%	87.5%
Slope stability failure	5.9%	14.3%	27.1%	27.1%	27.1%	57.8%
Embankment failure	14.3%	27.1%	27.1%	27.1%	57.8%	87.5%

The next step entails estimating conditional probabilities to represent the probability of a canal closure that could be caused by a single structural failure. The conditional aspect of the failure of a single structure means that the other structures do not fail. For instance, a drop structure can only fail if the other measures (siphon, underdrains, slope stability, and embankment) have not failed. The probabilities of failure for each structure are computed with the following formula, which is illustrated with the probability of a Siphon failure.

$$P(S_F \mid \textit{Other Measures Not Fail}) = P(S_F) \cdot (1 - [P(1 - D_F) \cdot P(1 - U_F) \cdot P(1 - SS_F) \cdot P(1 - E_F)])$$

Where $P(S_F)$ = Probability of Siphon failure, $P(D_F)$ = Probability of Drop Structure failure, $P(U_F)$ = Probability of Underdrain failure, $P(SS_F)$ = Probability of Slope Stability failure, *P(UF)* = Probability of Embankment failure, and 1 minus any of these probability failures is the probability that that measure does not fail. The conditional probability of a failure of any measure includes the probability that none of the other measures have failed. These results are found below in Table D5-14.

Table D5-14: 3-Year Conditional Probabilities of Failure, per Time Period

Potential Failures	Period of Years					
No Action Condition (Alt 1)	**2025 – 2028**	**2028 – 2033**	**2033 – 2038**	**2038 – 2043**	**2043 – 2048**	**Long Term**
Siphon failure	70.0%	80.0%	90.0%	100.0%	100.0%	100.0%
Drop structure failure	87.5%	93.6%	97.3%	99.2%	99.9%	100.0%
Underdrain failure	93.6%	97.3%	99.2%	99.9%	100.0%	100.0%
Slope stability failure	65.7%	78.4%	87.5%	87.5%	87.5%	87.5%
Embankment failure	99.1%	99.2%	99.2%	99.2%	99.2%	99.2%
Action Condition (Alts. 2 or 3)	**2025 – 2034**	**2034 – 2044**	**2044 – 2054**	**2054 – 2064**	**2064 – 2074**	**Long Term**
Siphon failure	0.2%	0.9%	3.0%	7.2%	23.6%	50.0%
Drop structure failure	0.7%	2.5%	8.1%	17.7%	52.2%	87.2%
Underdrain failure	0.7%	2.5%	8.1%	17.7%	52.2%	87.2%
Slope stability failure	1.2%	5.2%	13.3%	17.7%	25.6%	57.8%
Embankment failure	1.8%	6.9%	13.3%	17.7%	52.2%	87.2%

Water Delivery Benefits of Reliability

The benefits of enhanced reliability are captured as a reduction in the risk of a failure in the context of the No-Action/FWOFI Alternative. The risk of failure to each structure is evaluated separately based on the annual probability of failure and the period of canal closure if the structure fails. Table D5-15 indicates that substantial losses could occur if the project measures are implemented to avoid a sudden failure. For instance, if the siphon fails in the No-Action Alternative, water users would lose a discounted value of $192.2 million. However, with either Alternative 2 or 3, the potential loss of a new siphon structure decreases to a discounted loss of $49.4 million. Accounting for all potential sources of failure over the 100 year period, the losses would reduce from present values of $220.54 million in Alternative 1 to $38.73 million in either Alternatives 2 or 3, which would entail repairs and replacements to these canal measures.

Table D5-15: Discounted Value of Water Delivery Loss due to Structural Failures ($M)

Project Measures	Alternative 1 (No Action)
Siphon failure	-$166.83
Drop structure failure	-$36.81
Underdrain failure	-$6.63
Slope stability failure	-$6.97
Embankment failure	-$3.29
Total discounted loss	-$220.54
Project Measures	**Alternative 2 or 3**
Siphon failure	-$23.44
Drop structure failure	-$10.09
Underdrain failure	-$2.30
Slope stability failure	-$1.68
Embankment failure	-$1.22
Total discounted loss	-$38.73

D5.4.4 Water Delivery Enhanced Maintenance Efficiency Benefits

Two additional project measures (maintenance roads, wasteways with spillways) would support the improved canal by enabling regular maintenance and efficiently addressing canal failures. The benefits analyzed here only include the ways that these project measures enable reconstruction if a canal structure fails. If these project measures are not included in a canal modernization alternative, there would be additional delays in re-opening the canal after a failure. The additional delays would apply to any of failure discussed in the previous section. The benefits of these project measures are evaluated by computing the difference in discounted value of avoided failures with and without these measures.

Consequences of Failure

Table D5-16 presents the data used to evaluate the benefits of project measures to enhance maintenance efficiency. If any canal structure fails and the Action Alternative improvements to the maintenance road are not in place, canal operations would be delayed by an additional 0.5 to 2 months. For instance, if a drop structure fails and 4.5 months are required to rebuild the structure and re-open the canal, without road improvements, the closure would last 1.25 months longer, on average. This added delay extends the total duration of canal closure to about 5.75 months. The durations in Table D5-12 assume that both the improved maintenance road, wasteways, and spillways are included in the project. If these project measures are excluded, then there would be longer delays in restoring water deliveries. The analysis computes losses with and without these measures, using the average amount of potential additional delays, based on ranges shown in Table D5-16.

Table D5-16: Project Measures to Enhance Maintenance Efficiency

Project Measure	Added Delay in Canal Operations, if Failure Occurs
Improved maintenance road	0.5 to 2 months
Repaired wasteways & spillways	0.25 to 1 month

Water Delivery Benefits of Enhanced Maintenance Efficiency

The benefits of enhanced maintenance efficiency with project measures are evaluated by examining the potential impact of a failure for any of the structures that would be replaced to enhance reliability. The benefits for the improved maintenance road, wasteways, and spillways are computed as the difference in losses in water deliveries due to a failure with and without improvements to these measures, respectively.

The losses that could occur in the No-Action/FWOFI Alternative are presented in Table D5-17 with and without an improved roadway. Without an improved roadway, additional delays in re-opening the canal would occur, and this increases the total reduction in water deliveries. For instance, without an improved roadway, a siphon failure would lead to a discounted value $116.51 million loss, but with the improved road, the discounted value losses would reduce to $110.08 million. The impact then of implementing roadway improvements would be avoiding a discounted value $6.43 million loss. Overall, without an improved roadway, failures could lead to a discounted $175.35 million loss. With the reduced probabilities of failure in Alternatives 2 or 3, the reduction in net losses with the road would amount to a discounted value of $8.05 million.

Table D5-17: Discounted Value of Losses of Water Delivery with Improved Maintenance Road ($M)

	Losses Without Improved Roadway	Losses With Improved Roadway	Net Losses With Improved Roadway
Project Elements	**Alt 1 (No Action)**	**Alt 1 (No Action)**	**Alt 1 (No Action)**
Siphon failure	-$116.51	-$110.08	-$6.43
Drop structure failure	-$31.04	-$24.29	-$6.75
Underdrain failure	-$9.85	-$4.38	-$5.47
Slope stability failure	-$10.35	-$4.60	-$5.75
Embankment failure	-$7.60	-$2.17	-$5.43
Total discounted loss	-$175.35	-$145.52	-$29.83
Project Elements	**Alt 2 or Alt 3**	**Alt 2 or Alt 3**	**Alt 2 or Alt 3**
Siphon failure	-$16.37	-$15.47	-$0.90
Drop structure failure	-$8.51	-$6.66	-$1.85
Underdrain failure	-$3.42	-$1.52	-$1.90
Slope stability failure	-$2.49	-$1.11	-$1.38
Embankment failure	-$2.82	-$0.81	-$2.02
Total discounted loss	-$33.61	-$25.56	-$8.05

Losses with and without wasteways with spillways are presented in Table D5-18 and are evaluated the same way as the maintenance road. Overall, repairing wasteways and spillways would avoid $22.6 million in discounted value losses under the No-Action Alternative. With improvements, the remaining risk of losses is a discounted loss of $6.1 million.

Table D5-18: Discounted Value of Losses of Water Delivery with Improved Wasteways & Spillways ($M)

	Losses Without Improved Wasteways & Spillways	Losses With Improved Wasteways & Spillways	Net Losses With Improved Wasteways & Spillways
Project Elements	**Alt 1 (No Action)**	**Alt 1 (No Action)**	**Alt 1 (No Action)**
Siphon failure	-$171.71	-$166.83	-$4.87
Drop structure failure	-$41.93	-$36.81	-$5.11
Underdrain failure	-$10.78	-$6.63	-$4.15
Slope stability failure	-$11.32	-$6.97	-$4.36
Embankment failure	-$7.41	-$3.29	-$4.12
Total discounted loss	-$243.14	-$220.54	-$22.60
Project Elements	**Alt 2 or 3**	**Alt 2 or 3**	**Alt 2 or 3**
Siphon failure	-$24.13	-$23.44	-$0.69
Drop structure failure	-$11.49	-$10.09	-$1.40
Underdrain failure	-$3.74	-$2.30	-$1.44
Slope stability failure	-$2.73	-$1.68	-$1.05
Embankment failure	-$2.75	-$1.22	-$1.53
Total discounted loss	-$44.84	-$38.73	-$6.10

D5.5 Recreational Benefits

Fresno Reservoir and Nelson Reservoir receive water from the canal. Both reservoirs are enjoyed by people for recreational purposes. Changes in water delivery from the canal can affect recreational activity, because these deliveries alter the storage levels and surface area available for such activity. Alternatives 2 and 3 affect water deliveries to these reservoirs by increasing the volume of water conveyed and increasing reliability (by avoiding failures). Accordingly, an analysis of recreational benefits is conducted to estimate how changes in water deliveries to the reservoir can affect levels of recreational activity. The value of changes in recreational activity is based on estimates from the 2019 Reclamation analysis for the value of a visitor day to these reservoirs and other analytical parameters.

D5.5.1 Recreational Activity Value

Recreational Activity

Data on anglers using the Fresno and Nelson Reservoirs were obtained from the State of Montana (Montana Department of Fish, Wildlife, and Parks 2023) and the 2019 Reclamation analysis. This data, shown in Table D5-19,[17] indicates that anglers represent 75 percent of the total number of visitors to these reservoirs. Other visitors participate in activities such as

[17] Montana (2023). Montana Fish and Wildlife Statistics. Data on Fishing Pressure for Fresno Reservoir and Nelson Reservoir. Data site accessed 3/6/24: https://myfwp.mt.gov/fishMT/waterbody/40335 and https://myfwp.mt.gov/fishMT/waterbody/40513.

camping and hiking. Accordingly, the total number of visitors to these reservoirs can be estimated by dividing the number of anglers by 75 percent. The estimated average annual number of visitors to Fresno and Nelson Reservoirs are estimated to be 18,586 and 21,355 persons, respectively (see Table D5-19).

The 2019 Reclamation analysis also indicates that water storage levels in Nelson Reservoir are partially influenced by water levels in Fresno Reservoir. The 2019 Reclamation analysis analyzed the contribution of Fresno Reservoir to Nelson Reservoir based on a hydrologic assessment of their water surface elevations and surface areas. This analysis indicates that only about 19 percent of the surface area of Nelson Reservoir is hydrologically dependent on the surface area of Fresno Reservoir. Accordingly, the 2019 Reclamation analysis assumes that changes in Fresno Reservoir volumes would affect 19 percent of the total number of visitors at Nelson. This is assuming that visitors in both reservoirs are primarily influenced by their water surface areas. Thus, the average annual visitors affected by changes in inflows to Fresno Reservoir are 19 percent of 21,355 total visitors, or 4,074 visitors. The combined total of Fresno and Nelson Reservoir visitors who are affected by water inflows into Fresno Reservoir amounts to 22,660 visitors per year.

Table D5-19: Recreational Activity at Fresno and Nelson Reservoirs

Year	Fresno Reservoir – Anglers	Nelson Reservoir – Anglers
2013	21,289	21,474
2015	23,033	16,399
2017	4,370	14,672
2019	11,151	18,068
2020	11,965	13,711
2021	11,829	11,775
Average Annual Anglers	13,940	16,017
	Fresno Reservoir – All Visitors	**Nelson Reservoir – All Visitors**
Average annual visitors	**18,586**	**21,355**
Average annual visitors affected by inflows to Fresno Reservoir	**18,586**	**4,074**
Annual number of visitors affected by inflows to Fresno Reservoir	**22,660**	

Changes in Recreational Activity Relative to Water Inflows

The analysis of changes in recreational activity, combining visitors to Fresno and Nelson Reservoirs, uses data from Hydromet data (Reclamation 2023) for the Fresno Reservoir.[18] The analysis focuses on data related to the total inflow of volumes of water into Fresno Reservoir and the percentage of storage capacity at Fresno Reservoir. Two linear statistical analyses are formed to relate inflows to visitor activity as follows:

1. Percent of storage capacity, as a function of total inflow volumes

[18] Reclamation (2023). Hydromet - Daily Data. Fresno Reservoir (FRR Station ID). Data accessed 3/1/2024 from: HydroMet (usbr.gov)

2. Annual number of anglers, as a function of percentage of storage capacity

The years of analysis include data from 2013 through 2020, as shown in Table D5-20. The data plots for the two statistical models are shown I n Figure D5-2: Data and Statistical Models to Estimate Angler Days, as a function of Inflow and include statistical results in the charts. The statistical analyses indicate (as hypothesized) positive “slope” parameters (representing the change in one parameter relative to another) in each model, which indicates that higher levels of water inflow are associated with higher levels of angler activity. This analysis is conducted with a caveat that the results of the models can only provide an indicative connection between total inflows to Fresno Reservoir and angler days. Neither estimated model provides a robust fit of the data since both models have relatively low r^2 values and the p-values for the slope coefficients are not significant at the 10 percent level. Also, the model estimates *angler days* as a function of *total inflow volumes* does not show a statistically significant relationship. As a result, the statistical models cannot reject with high confidence that *angler days* are unaffected by *total inflow volumes.* In using these results, it is assumed still that the slope coefficients produce reasonable order-of-magnitude results. If more years of data were available, along with other potential explanatory variables, it is expected that the estimated parameters would be more statistically significant.

Table D5-20: Data to Estimate Angler Days, as a Function of Total Inflows

Year	Annual Angler Days at Fresno Reservoir	Average Percent Storage (July – Sept) at Fresno Reservoir	Total Inflows (Oct – Sept) to Fresno Reservoir
2013	21,289	77	247,791
2015	23,033	63	193,130
2017	4,370	33	228,778
2019	11,151	69	211,268
2020	11,965	32	104,741
2021	11,829	35	221,964

The results from the two statistical models (see Figure D5-2) are used in a two-step process to determine how a change in *total inflow* effects *annual angler days*. That is, first a change in *average percent storage* is estimated from a change in *total inflow*. This change in *average percent storage* is used to estimate a change in a*nnual angler days.* The *annual angler days* are computed for the quantity of conveyance for each alternative.

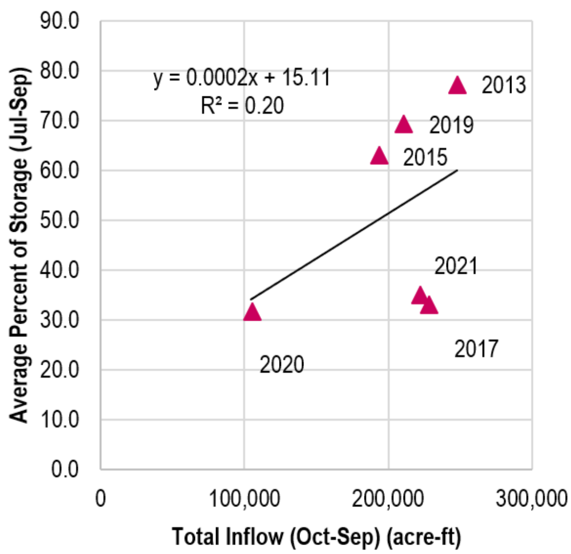
Results of the statistical analyses and estimation of anglers at Fresno Reservoir are shown in Table D5-21. Based on these data, first the change in percentage storage is computed for this level of inflow, and then in the second stage, this percentage storage is used to determine the number of annual anglers at Fresno Reservoir. The data indicate that 12,394 anglers would visit Fresno under the No-Action/FWOFI Alternative, but the higher volumes would lead to over 13,000 anglers, depending on the alternative.

Table D5-21: Estimated Numbers of Anglers at Fresno Reservoir, based on Water Conveyance

	Alternative 1	Alternative 2	Alternative 3
Annual water inflow to Fresno (AAF)	164,944	193,266	186,482
Estimated change in percent storage	45	50	49
Estimated annual anglers at Fresno Reservoir	**12,394**	**13,599**	**13,310**
Difference in annual anglers at Fresno Reservoir	**0**	**1,205**	**916**

Figure D5-2: Data and Statistical Models to Estimate Angler Days, as a function of Inflow

Statistical Model 1	Statistical Model 2
[Average Percent Storage] = 0.0002*[Total Inflows] + 15.11 $R^2 = 0.20$	[Annual Angler Days] = 234.34*[Average Percent Storage] + 1835.6 $R^2 = 0.47$



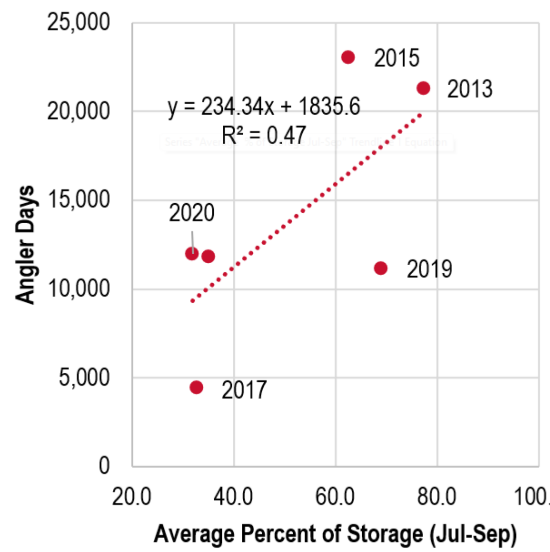


Table D5-22 extends the number of potential recreational beneficiaries for water conveyance to all visitors at Fresno and Nelson Reservoirs. TXhis adjustment includes (a) added Nelson Reservoir anglers, which are estimated to be 20 percent of Fresno Reservoir anglers; and (b) other recreational visitors, which amount to 33 percent of anglers.

Table D5-22: Recreational Activity as a function of Monthly Water Delivery

	Alternative 1	Alternative 2	Alternative 3
Estimated annual anglers at Fresno	12,394	13,599	13,310
Total number of annual anglers at Nelson	2,717	2,981	2,918
Total number of annual visitors	**20,148**	**22,106**	**21,637**
Difference in total annual visitors, with-project		**1,958**	**1,489**

Value of Recreational Activity Day

The approach to estimating values for recreational activities adopts the same approach as the 2019 Reclamation analysis. This report evaluated recreation benefits by following standard economic guidelines related to differences in with-project and without-project conditions.

Recreational activities at Fresno and Nelson Reservoirs include fishing, boating, camping, hunting, picnicking, and wildlife viewing. The 2019 Reclamation analysis reports that approximately 75 percent of Fresno Reservoir visits are angling related. Similar preferences for activities occur on the Nelson Reservoir. The 2019 Reclamation analysis assessed the substitutability of Fresno and Nelson Reservoirs and concluded that there are very limited alternatives. It states that “the closest substitutes, with a similar quality of experience, are Lake Elwell (also known as Tiber Reservoir), which is about 90 miles west of Fresno Reservoir, and Nelson Reservoir, which is about 130 miles east of Fresno Reservoir. A third reservoir, Bailey Reservoir, is about 30 miles south of Fresno Reservoir, but much smaller and offers very limited recreation opportunities compared to Fresno Reservoir.”

The value of recreation is estimated as a net consumer surplus of a recreation visit for a one-day trip. The consumer surplus equals the difference between what consumers are willing to pay for a recreation experience and what they would pay for that experience. This approach accounts for the substitution of a less desirable site if Fresno and Nelson Reservoirs were unavailable. While the 2019 Reclamation analysis stated Tiber reservoir is the nearest substitute based on the quality of experience, the 90-mile drive is likely not practical for it to be an absolute substitute.

The 2019 Reclamation analysis applies a benefit transfer approach for different recreational activities, using research by Rosenberger (2016). The 2019 Reclamation analysis uses the median of a series of economic values from studies conducted after 1980. These were all conducted in the Western Census Region for recreation sites associated with lake and reservoir locations. The consumer surplus value for a typical day is computed as a weighted average of activities in fishing, boating, camping, picnicking, wildlife viewing, and hunting. The resulting value for a recreational day at Fresno and Nelson Reservoirs was found to be $37.39 (in 2018 dollars). After adjusting for inflation, the value of a recreational day in this analysis is estimated to be $48.60 (in 2025 dollars), as shown in Table D5-23.

Table D5-23: Daily Value of Recreation Activity

	Recreation Day Value (2018)	Recreation Day Value (2025)
Fresno Reservoir	$37.39	$48.60
Nelson Reservoir	$37.39	$48.60

The analysis of recreational benefits discussed next includes the same contexts as water delivery benefits, which is not surprising since recreational activity depends on water delivery. As with water delivery benefits, the contexts for recreational benefits include: (a) Increased water conveyance; (b) Enhanced reliability; and (c) Enhanced maintenance efficiency. This section reports results of the present value estimate of benefits. This combines the value per visitor day ($48.60) and the change in number of visitors, for each context.

D5.5.2 Recreational Benefits of Increased Water Conveyance

Table D5-24 presents the results of the analysis of recreational benefits associated with increased water conveyance. The table indicates the value from the difference in delivered water (after accounting for losses), the corresponding change in annual numbers of visitors to the reservoirs, the value per visitor-day, and the total present value benefits. Present value benefits assume a 100-year planning horizon and a 3.25 percent discount rate. Similar to other benefit categories and contexts, higher benefits are found for Alternative 2 than Alternative 3 because of the larger increase in delivered water.

Table D5-24: Discounted Recreational Benefits of Increased Water Conveyance

	Alternative 1	Alternative 2	Alternative 3
Water diversion (AF / year)	164,944	193,266	186,482
Total number of annual visitors	20,148	22,106	21,637
Total benefits ($M)	**$28.90**	**$31.70**	**$31.03**
Total benefits, action alternatives ($M)		**$2.81**	**$2.14**

D5.5.3 Recreational Benefits of Enhanced Reliability

The recreational benefits of enhanced reliability are evaluated similarly to water delivery benefits. That is, the monthly delivered AF and associated level of visitors (Table D5-22) combines with the duration of canal closure due to a structural failure to determine the loss of visitor days for each month that the canal is closed. Benefits are computed by combining the annual likelihood of structural failures and avoided canal closure period for the current numbers of visitors associated with existing reservoir conditions (not the additional volumes, which could increase visitors). Lost visitor days are monetized with the value per visitor day. Results in Table D5-25 indicate the total present values of recreational benefits of avoiding canal closures. This analysis assumes that these benefits are equivalent to avoided losses under the No-Action Alternative if these measures are not implemented. Discounted losses in recreational value relative to a No-Action condition would amount to $20.72 million but drop to $3.21 million in losses with improved structures.

Table D5-25: Discounted Value of Recreational Losses due to Structural Failures ($M)

Project Measures	Alternative 1 (No Action)
Siphon failure	-$15.20
Drop structure failure	-$3.60
Underdrain failure	-$0.81
Slope stability failure	-$0.69
Embankment failure	-$0.41
Total discounted loss	-$20.72
Project Measures	**Alternative 2 or 3**
Siphon failure	-$1.94
Drop structure failure	-$0.84
Underdrain failure	-$0.19
Slope stability failure	-$0.14
Embankment failure	-$0.10
Total discounted loss	-$3.21

D5.5.4 Recreational Benefits of Enhanced Maintenance Efficiency

The recreational benefits of enhanced maintenance efficiency are analyzed in the same approach as water delivery benefits. That is, if the project measures to enhance maintenance are excluded from the project, the periods of canal closure would increase. Both maintenance roads and wasteways with spillways are analyzed separately to determine the net benefits of including these measures. In each case, the loss in recreational benefits is determined for the number of months that a canal is closed due to a failure, as a difference in with and without the enhanced maintenance efficiency measure. Related recreational benefits of an improved maintenance road are provided in Table D5-26.

The losses to recreational activity that could occur under the No-Action/FWOFI Alternative are presented in Table D5-27 with and without an improved roadway. Without an improved roadway, additional delays in re-opening the canal would occur, and this increases the total reduction in recreational access. For instance, without an improved roadway, a siphon failure would lead to a present value $10.62 million in losses, but with the improved road, the discounted value losses would reduce to $10.03 million. The impact on siphon then of implementing roadway improvements would be avoiding a discounted value $0.59 million in losses. Overall, without an improved roadway, all potential failures could amount to a discounted value of $3.16 million in losses. With improvements, the remaining risk of a failure in Alternatives 2 or 3 would amount to a discounted loss of $0.67 million.

Table D5-26: Discounted Value of Recreational Losses Due to Roadway Improvement ($M)

	Losses Without Improved Roadway	Losses With Improved Roadway	Net Losses With Improved Roadway
Project Elements	**Alt 1 (No Action)**	**Alt 1 (No Action)**	**Alt 1 (No Action)**
Siphon failure	-$10.62	-$10.03	-$0.59
Drop structure failure	-$3.04	-$2.38	-$0.66
Underdrain failure	-$1.21	-$0.54	-$0.67
Slope stability failure	-$1.02	-$0.45	-$0.57
Embankment failure	-$0.95	-$0.27	-$0.68
Total discounted loss	-$16.83	-$13.67	-$3.16
Project Elements	**Alt 2 or Alt 3**	**Alt 2 or Alt 3**	**Alt 2 or Alt 3**
Siphon failure	-$1.35	-$1.28	-$0.07
Drop structure failure	-$0.71	-$0.56	-$0.15
Underdrain failure	-$0.28	-$0.12	-$0.15
Slope stability failure	-$0.21	-$0.09	-$0.12
Embankment failure	-$0.24	-$0.07	-$0.17
Total discounted loss	-$2.78	-$2.12	-$0.67

Recreational benefits of wasteways with spillways are evaluated the same way as road maintenance. Benefits of wasteways with spillways are lower than those for the maintenance road because the absence of a road would cause longer delays in re-opening the canal. Overall, the improved wasteways with spillways reduce losses under the No-Action Alternative by $2.39 million. With improvements, failures in Alternatives 2 or 3 would amount to a discounted loss of $0.51 million.

Table D5-27: Discounted Value of Recreational Losses due to Wasteways and Spillways ($M)

	Losses Without Improved Wasteways & Spillways	Losses With Improved Wasteways & Spillways	Net Losses With Improved Wasteways & Spillways
Project Elements	**Alt 1 (No Action)**	**Alt 1 (No Action)**	**Alt 1 (No Action)**
Siphon failure	-$15.65	-$15.20	-$0.44
Drop structure failure	-$4.10	-$3.60	-$0.50
Underdrain failure	-$1.32	-$0.81	-$0.51
Slope stability failure	-$1.11	-$0.69	-$0.43
Embankment failure	-$0.92	-$0.41	-$0.51
Total discounted loss	-$23.11	-$20.72	-$2.39
Project Elements	**Alt 2 or 3**	**Alt 2 or 3**	**Alt 2 or 3**
Siphon failure	-$2.00	-$1.94	-$0.06
Drop structure failure	-$0.96	-$0.84	-$0.12
Underdrain failure	-$0.30	-$0.19	-$0.12
Slope stability failure	-$0.23	-$0.14	-$0.09
Embankment failure	-$0.23	-$0.10	-$0.13
Total discounted loss	-$3.71	-$3.21	-$0.51

D5.5.5 Summary of Benefits

The summary of all benefits discussed above is contained in Table D5-21. As shown, the value of water delivery with higher volumes of water conveyance in Alternatives 2 and 3 is higher than the baseline water delivery in the existing canal, represented by the No-Action condition in Alternative 1. Based on the data in Table D5-28, approximately 98.6% of water delivery benefits would accrue to irrigators and the rest for M&I consumers. The benefits of failures to existing structures and measures that could enhance maintenance efficiency are all negative in the No-Action condition because of current vulnerabilities in the system. These reliability and efficiency benefits become positive if these measures are incorporated into either Alternative 2 or 3.

Table D5-28: Discounted Value of Total Benefits for All Benefit Categories ($M)

	Water Delivery			Recreational Value			Total Benefits		
Project Measures	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 1**	**Alt 2**	**Alt 3**
Canal conveyance (with or without lining)	$339.0	$397.2	$383.3	$28.9	$31.7	$31.0	$367.9	$428.9	$414.3
Siphons	-$166.8	-$23.4	-$23.4	-$15.2	-$1.9	-$1.9	-$182.0	-$25.4	-$25.4
Drop structures	-$36.8	-$10.1	-$10.1	-$3.6	-$0.8	-$0.8	-$40.4	-$10.9	-$10.9
Underdrains	-$6.6	-$2.3	-$2.3	-$0.8	-$0.2	-$0.2	-$7.4	-$2.5	-$2.5
Slope stability	-$7.0	-$1.7	-$1.7	-$0.7	-$0.1	-$0.1	-$7.7	-$1.8	-$1.8
Embankment	-$3.3	-$1.2	-$1.2	-$0.4	-$0.1	-$0.1	-$3.7	-$1.3	-$1.3
Maintenance road	-$29.8	-$8.1	-$8.1	-$3.2	-$0.7	-$0.7	-$33.0	-$8.7	-$8.7
Wasteways / spillways	-$22.6	-$6.1	-$6.1	-$2.4	-$0.5	-$0.5	-$25.0	-$6.6	-$6.6
Total benefits	**$66.0**	**$344.3**	**$330.4**	**$2.6**	**$27.3**	**$26.7**	**$68.6**	**$371.6**	**$357.0**

Table D5-29: Discounted Value of Total Benefits for All Benefit Categories ($M)

	Annualized Benefits		
Project Measures	**Alt 1**	**Alt 2**	**Alt 3**
Canal conveyance (with or without lining)	$12.47	$14.53	$14.04
Siphon	-$6.17	-$0.86	-$0.86
Drop structures	-$1.37	-$0.37	-$0.37
Underdrains	-$0.25	-$0.08	-$0.08
Slope stability	-$0.26	-$0.06	-$0.06
Embankment	-$0.13	-$0.04	-$0.04
Maintenance road	-$1.12	-$0.30	-$0.30
Wasteways / spillways	-$0.85	-$0.22	-$0.22
Total Benefits	**$2.33**	**$12.59**	**$12.10**

As noted in the introductory discussion of this section, these annualized benefits are all discounted to 2025. Below, the NEE net present value is determined as the present value of these benefits and costs according to the year that they occur, after construction is completed.

D5.5.6 Considerations of Uncertainties and Impacts on Results

This analysis includes many different drivers of value, and the uncertainties in each of the key parameter values could drive benefits higher or lower. For instance, some of these uncertainties and impact on results include:

- Operations and Maintenance (O&M) costs: Currently, the cost estimate includes 2 percent of annual spending every year for a 100-year period. If the actual O&M expenditures turn out to be lower than this amount, the present value of net benefits would increase.
- Cropping patterns: As noted above, no change is made in this analysis to reflect potential differences in cropping patterns that exist today. Updates to cropping patterns, along with associated expenses and revenues, have an uncertain impact. It may be that irrigation systems have even greater net returns.
- Water diversion: The model is based on an average diversion rate of 164,944 AF per year. From year to year, this volume may fluctuate. If the baseline average diversion rate is lower than 175,339 AF per year, the benefits of increasing to 193,266 AF per year would generate higher average annual benefits for water delivery and recreational activity.
- Water delivery: Seepage losses are estimated to reduce deliveries by 9.4 percent. If seepage or other losses are higher, total benefits of water delivery and recreational activity would be lower.
- Failure characteristics: The model accounts for the potential of independent failures of each project element over a 3-year period, based on the probabilities of failure. If a failure occurs, it is assumed that water deliveries would be delayed for a period of months. If the probability of failure is lower than that anticipated under the No-Action Alternative, the benefits would decline. Also, if the duration of re-construction after a failure is lower than anticipated, benefits would also decline. However, if the probability of failure is lower or durations increase under the Action Alternatives, the benefits of reliability would increase.

D5.6 Ecosystem Services Evaluated

D5.6.1 Types of Services Impacted

Provisioning Services, Regulating Services, and Cultural Services would be impacted by Alternative 1, Alternative 2, and Alternative 3. A discussion of the tradeoffs for each of the services can be found below.

D5.7 Provisioning Services

Alternative 1 would continue to provide unreliable irrigation and municipal water supply. Negative impacts to fish species in the North Fork Milk River and Milk River would continue due to availability of water and ability of the system to support fish species.

Alternative 2 modernization measures would help provide more secure and reliable irrigation and municipal water supply and would provide a beneficial effect on fish species within the North Fork Milk River and Milk River by increasing the canal discharge rate to the original design capacity of 850 cfs. A minor effect and benefit to fish species within the St. Mary River downstream of the point of diversion could occur due to the acclimation to a discharge rate from say 600 cfs and potentially up to 850 cfs.

Alternative 3 modernization measures would provide a secure and reliable irrigation and municipal water supply and would provide a beneficial effect on fish species within the North Fork Milk River and Milk River by increasing the canal discharge rate to the original design capacity of 850 cfs. A minor effect and benefit to fish species within the St. Mary River downstream of the point of diversion could occur due to the acclimation to a discharge rate of 600 cfs and increase to 850 cfs.

D5.8 Regulating Services

Alternative 1 would have no effect on existing surface water quality and would remain unchanged.

Alternative 2 would have a temporary, short-term, negligible effect on water quality from construction and a long-term, minor, beneficial effect on water to waterbodies that receive Milk River Project water.

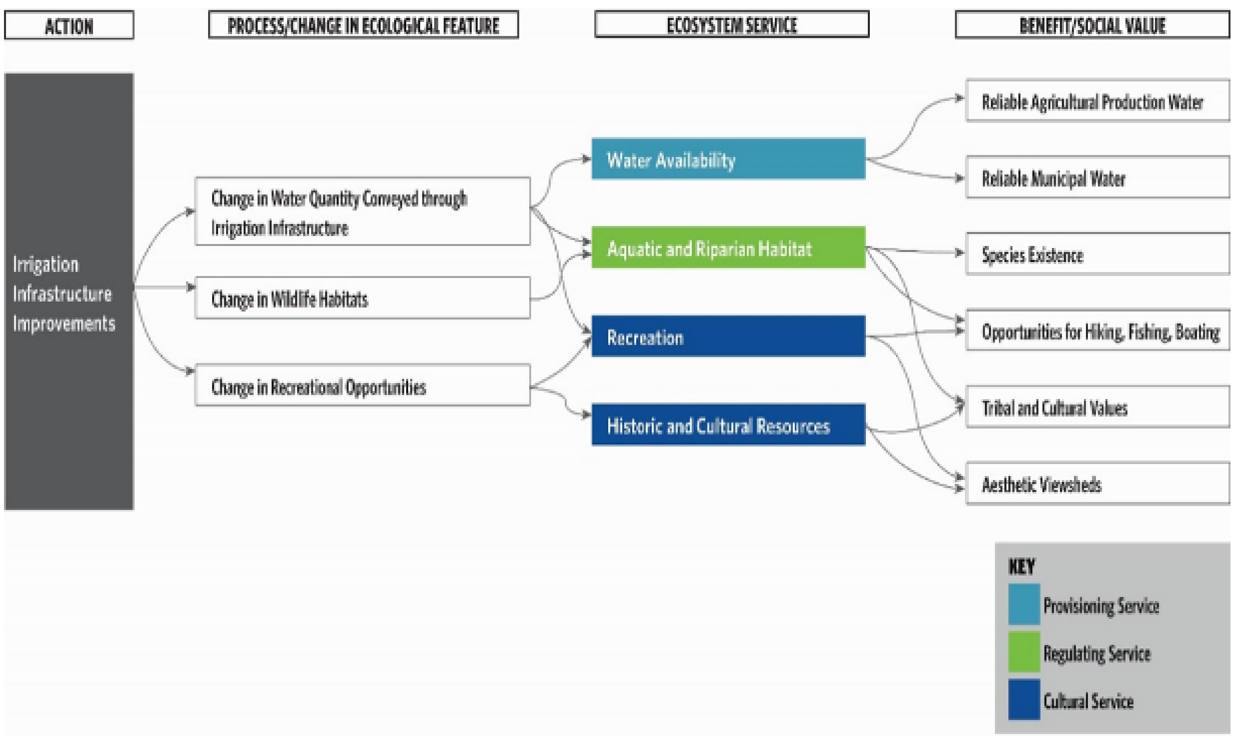
Alternative 3 would have a temporary, short-term negligible effect due to the construction and a long-term, minor, beneficial effect on water quality to waterbodies that receive Milk River Project water.

D5.9 Cultural Services

Alternative 1 would have no effect on historic and cultural resources and would remain unchanged. Recreation would be moderately affected due to the reduced water levels within Fresno Reservoir.

Alternative 2 would have an adverse effect on historic and cultural resources. A Memorandum of Agreement and a treatment plan would be developed to address these effects. The water level at Fresno Reservoir would increase, leading to a minor beneficial effect.

Alternative 3 would have an adverse effect on historic and cultural resources. A Memorandum of Agreement and a treatment plan would be developed to address these effects. The water level at Fresno Reservoir would increase, leading to a minor beneficial effect.



D5.9.1 Ability to Characterize, Quantify, and Monetize Services

Standard project outcomes were monetized and are found in Section 3.1 of Appendix D.

D5.9.2 Summary of Ecosystem Service

A summary of the Preferred Alternative's impact on ecosystem services from the St. Mary Canal System and fulfillment of federal investment principles in water. The Preferred Alternative was created and supported through a local stakeholder process. As part of this process, stakeholders were invited to provide public comment and input into the design and evaluation of the Preferred Alternative. As a result of this input, the Preferred Alternative is the locally preferred alternative. The FWOFI is the non-structural alternative in that, without federal investment, there would be no change in the St. Mary Canal System and water delivery. The Preferred Alternative is the alternative that increases National Economic Efficiency by improving the St. Mary Canal System's provisioning services and increases regulating services, resulting in water delivery.

D5.10 Estimated Project Costs

Project capital and O&M costs are estimated in 2025 dollars for each project measure (see Table D5-30). Costs for each project measure are included as separate items. Costs exclude estimates of the impact of escalation to the midpoint of construction. The present value costs will be compared to present value benefits for each measure. O&M costs for each alternative are assumed to be 2 percent of the capital cost and are estimated to include the cost of an eventual replacement of the project measure. The O&M cost estimate is also assumed to account for the difference between current and with-project conditions O&M expenditures. Present value and annualized costs are computed with a 3.25 percent discount rate over 100 years.

Alternative 2 is estimated to cost $200.22 million in 2025 dollars while Alternative 3 would cost $153.71 million. The difference in these two alternatives is the additional cost for canal lining in Alternative 2. The costs for canal lining amount to approximately $46.5 million. These costs are not in present value terms, relative to when the costs would be incurred. Present value costs are discussed below.

Table D5-30: Estimated Costs of Project Measures ($2025)

	Alternative 2		Alternative 3	
Project Measure	**Capital ($M)**	**O&M ($M)**	**Capital ($M)**	**O&M ($M)**
Siphon	$3.99	$0.06	$3.99	$0.06
Drops structures	$23.74	$0.36	$23.74	$0.36
Slides	$67.98	$1.04	$67.98	$1.04
Canal measures (various)	$102.65	$1.60	$56.13	$0.85
Roads	$1.87	$0.03	$1.87	$0.03
Total	**$200.22**	**$3.09**	**$153.71**	**$2.34**

Assumptions: **Siphon** (Includes Kennedy Creek); **Drops** (Includes Structures 1&3, 4); **Slides** (Schedule using estimate of 3,000 CY per day.); **Canal** (Assumes: 4-5 canal miles per year can be completed. Start west and work east. Most work done during shoulder seasons. In addition to canal lining and reshaping, canal work also includes wasteways, side channel spillways and underdrains and Kennedy Creek Siphon; **Roads** (Assumes: Maintenance Road to be a 12-foot-wide all-weather access with 6 inches of compacted gravel surfacing at conclusion of major infrastructure projects. Road improvements will be done concurrently with neighboring construction activities (e.g., Canal Construction). Once construction is complete, the condition of the road will be evaluated and one construction season spent improving it to be an all-weather access road with a descent subgrade, slope, drainage and gravel surface.

D5.11 Summary of the NEE Analysis

D5.11.1 NEE Net Present Value

The results of the BCA for the Action Alternatives are compared against the No-Action Alternative and serve as the best estimate of the additional economic value that would be created. The results discussed in the earlier section are an initial computation of benefits to generate annualized benefits relative to a present value year of 2025. This section presents results relative to when costs are incurred and when benefits are accrued after project implementation is completed. The implementation schedule and cost profile for the net present value NEE analysis assumes the following plan. As shown in Table D5-31, the project would begin with replacing siphons in 2027 and take 1 year to complete with 100 percent of total costs spent annually. Note that canal measures include costs for canal lining and reshaping and repair of wasteways, spillways, underdrains, and other measures (see notes in Table D5-30).

Table D5-31: Project Implementation Schedule for Each Project Measure

Project Measure	Start Year of Construction	Construction Duration Years	% Capital Cost Spending per Year	Year Benefits and O&M Costs Begin
Siphon	2027	1	100%	2028
Drop structures	2028	2	50%	2030
Slide mitigation	2030	1	100%	2031
Canal measures	2031	6	17%	2037
Road improvements	2037	1	100%	2038

The multi-year construction sequencing and varied starting years requires several steps to determine a present value of spending on an equivalent year basis. For instance, siphons would be implemented first, take 1 year to complete, and cost $4 million in 2025 terms. 100 percent of spending would occur in 2027, which amounts to $4 million in present value, that is, if construction started in 2025. Since construction is delayed until 2027, the present value costs in 2025 are further discounted to reflect a present value of spending in 2026 and 2027. The present value cost of each project measures entails a 2-stage discounting process. The total present value of all capital costs is $162.5 million for Alternative 2 and $127 million for Alternative 3, the difference in costs relates to canal lining only.

Table D5-32: Present Value Capital Costs for Each Project Measure

Project Measure	Start Year of Constr.	Total Constr. Costs, $2025 ($M)		PV Total Constr. Costs Relative to Start of Construction ($M)		PV Total Constr. Costs Relative to 2025 ($M)	
		Alt 2	Alt 3	Alt 2	Alt 3	Alt 2	Alt 3
Siphon	2027	$4.0	$4.0	$4.0	$4.0	$3.7	$3.7
Drop structures	2028	$23.7	$23.7	$23.4	$23.4	$21.2	$21.2
Slide mitigation	2030	$68.0	$68.0	$68.0	$68.0	$57.9	$57.9
Canal measures	2031	$102.6	$56.1	$94.9	$51.9	$78.3	$42.8
Road improvements	2037	$1.9	$1.9	$1.9	$1.9	$1.3	$1.3
Total		**$200.2**	**$153.7**	**$192.1**	**$149.1**	**$162.5**	**$127.0**

Annual O&M costs are estimated to require 2 percent of capital costs and last for 100 years. Annual O&M costs begin to be incurred after capital spending has been completed. The year that O&M spending begins is shown in Table D5-33. Similar to the process of computing the present value cost relative to the start year of O&M spending, two stages of discounting involve (a) computing the total discounted value of future annual O&M spending for all measures; and (b) applying a second discount factor to year 2025. The total present value of all O&M costs is $68.7 million for Alternative 2 and $53.7 million for Alternative 3, the difference in costs relates to O&M for the lined canal section.

Table D5-33: Present Value Annual O&M Costs for Each Project Measure

Project Measure	Start Year of O&M	Total Annual O&M Costs (2% of Capital Costs), $2025 ($M)		PV Total Annual Costs Relative to Start of Construction ($M)		PV Total Annual Costs Relative to 2025 ($M)	
		Alt 2	Alt 3	Alt 2	Alt 3	Alt 2	Alt 3
Siphons	2028	$0.1	$0.1	$1.8	$1.8	$1.6	$1.6
Drop structures	2030	$0.4	$0.4	$10.7	$10.7	$9.1	$9.1
Slide mitigation	2031	$1.0	$1.0	$30.5	$30.5	$25.2	$25.2
Canal measures	2037	$1.6	$0.9	$47.3	$25.2	$32.2	$17.2
Road improvements	2038	$0.0	$0.0	$0.8	$0.8	$0.5	$0.5
Total		**$3.1**	**$2.3**	**$91.1**	**$69.1**	**$68.7**	**$53.7**

Interest during construction (IDC) is computed with the same discount rate up to the midpoint of construction using the standard formula in the P&G. Similar to capital and O&M, a two-stage discounting approach is applied to estimate IDC based on the years when costs are incurred for each measure and the respective durations of construction. The total present value of all IDC costs are $8.7 million and $5.5 million for Alternatives 2 and 3, respectively.

Table D5-34: Present Value IDC Costs for Each Project Measure

Project Measure	Start Year of Constr.	Const. Duration	IDC Costs Relative to Start of Construction ($M)		PV IDC Costs Relative to 2025 ($M)	
			Alt 2	Alt 3	Alt 2	Alt 3
Siphons	2026	1	$0.1	$0.1	$0.1	$0.1
Drop structures	2028	2	$0.8	$0.8	$0.7	$0.7
Slide mitigation	2030	1	$1.1	$1.1	$0.9	$0.9
Canal measures	2031	6	$10.3	$5.7	$7.0	$3.9
Road improvements	2037	1	$0.0	$0.0	$0.0	$0.0
Total			**$12.3**	**$7.6**	**$8.7**	**$5.5**

Total costs, including capital, O&M, and IDC costs are presented in Table D5-35. The total present value of all costs is $239.87 million for Alternative 2 and $186.16 million for Alternative 3. The annualized NEE costs for these Alternatives are $8.13 million and $6.31 million, respectively.

Table D5-35: Present Value Total and Annual Costs for Each Project Measure

Project Measure	PV Total Costs Relative to 2025 ($M)		Annualized Costs Relative to 2025 ($M)	
	Alt 2	Alt 3	Alt 2	Alt 3
Siphons	$5.42	$5.42	$0.18	$0.18
Drop structures	$30.98	$30.98	$1.05	$1.05
Slide mitigation	$84.06	$84.06	$2.85	$2.85
Canal measures	$117.58	$63.87	$3.98	$2.16
Road improvements	$1.84	$1.84	$0.06	$0.06
Total	**$239.87**	**$186.16**	**$8.13**	**$6.31**

Annual benefits are estimated in an identical approach to O&M costs, where annualized benefits are spread over a 100-year period, and present value benefits relative to 2025 are computed by accounting for the different years when benefits for each structure begin. The total present value of all benefits across all measures is $302.99 million for Alternative 2 and $288.38 million for Alternative 3.

Table D5-36: Present Value Annual Benefits for Each Project Measure

Project Measure	Start Year of Benefits	Total Annual Benefits, $2025 ($M)		PV Total Benefits Relative to 2025 ($M)	
		Alt 2	Alt 3	Alt 2	Alt 3
Siphons	2028	$5.31	$5.31	$156.66	$156.66
Drop structures	2030	$1.00	$1.00	$29.48	$29.48
Slide mitigation	2031	$0.20	$0.20	$5.84	$5.84
Canal measures	2037	$2.94	$2.44	$86.74	$72.13
Road improvements	2038	$0.82	$0.82	$24.27	$24.27
Total		**$10.27**	**$9.77**	**$302.99**	**$288.38**

Annualized costs and benefits, net present value, and benefit-cost ratio are presented in Table D5-37 for each project measure and as a sum for each Alternative. The total net present value across all measures is a $63.12 million for Alternative 2 and $102.21 million for Alternative 3, which are equivalent to 1.26 and 1.55 benefit-cost ratios, respectively.

Table D5-37: Present Value Benefits and Costs for Each Project Measure

Project Measure	Alt 2 PV Benefits ($M)	Alt 3 PV Benefits ($M)	Alt 2 PV Costs ($M)	Alt 3 PV Costs ($M)	Alt 2 NPV ($M)	Alt 3 NPV ($M)	Alt 2 BC Ratio	Alt 3 BC Ratio
Siphons	$156.66	$156.66	$5.42	$5.42	$151.23	$151.23	28.88	28.88
Drop structures	$29.48	$29.48	$30.98	$30.98	-$1.49	-$1.49	0.95	0.95
Slide mitigation	$5.84	$5.84	$84.06	$84.06	-$78.22	-$78.22	0.07	0.07
Canal measures	$86.74	$72.13	$117.58	$63.87	-$30.83	$8.26	0.74	1.13
Road improvements	$24.27	$24.27	$1.84	$1.84	$22.43	$22.43	13.19	13.19
Total	**$302.99**	**$288.38**	**$239.87**	**$186.16**	**$63.12**	**$102.21**	**1.26**	**1.55**

D5.11.2 Comparison of Ecosystem Service Tradeoffs

Alternative 1 would continue to provide an unreliable irrigation and municipal water supply for provisioning services, but the tradeoff for Alternatives 2 and 3 would provide a more secure and reliable irrigation and municipal water supply for provisioning services. For fisheries under provisioning service, Alternative 1 would negatively impact fish species in the North Fork Milk River and Milk River due to availability of water and the St. Mary Canal System's ability to support fish species. The tradeoffs for Alternative 2 and 3 are a beneficial effect on fish species within the North Fork Milk River by increasing the canal discharge rate. Alternative 2 and 3 tradeoffs for the St. Mary River downstream of the point of diversion would have a minor impact on fish species as they are acclimated to the existing diversion rates.

Alternative 1 would have no effect on the existing surface water quality and it would remain unchanged. The tradeoffs for Alternative 2 and 3 are a temporary, short-term, negligible effect during construction and a long-term, minor, beneficial effect on water quality to waterbodies that received Milk River Project water.

Alternative 1 would have no effect on historic and cultural resources under Cultural Services. The tradeoff for Alternative 2 and 3 is an adverse effect; however, the development of a Memorandum of Agreement and treatment plan would be completed to avoid and minimize adverse effects. For recreation cultural services, Alternative 1 would have reduced water levels in Fresno Reservoir. The tradeoff for Alternative 2 and 3 is a minor beneficial effect due to the increased water levels in Fresno Reservoir.

D5.12 Incremental Analysis

Table D5-2 provides the host of project measures that comprise each Action Alternative. In order to provide a system that addresses increased water conveyance, enhanced reliability, and enhanced maintenance efficiency, each measure is integral. For instance, failure to replace all of the siphons or drop structures results in the same conveyance capacity. Further, there are no stand-alone measures that would be completed independently from one another. For example, in the process of canal shaping, improved maintenance roads would be installed to facilitate construction but would also serve for future maintenance access. Underdrains, wasteways, and spillways would be replaced as they would be impacted during canal shaping, and therefore, would be upgraded as appropriate. Additionally, all of the combined measures provided benefits to the same service area.

Because of the nature of canal modernization, all measures, with the exception of canal lining, are dependent on each other, and benefits will only be achieved once the entirety of the collective measures of an alternative have been completed. Canal lining is the only measure that has independent utility from the other measures. In this instance, that project measure was captured within Alternative 2, and therefore, is compared against Alternative 3. As such, there is no additional incremental analysis performed.

D5.13 Economic References

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